Evaluation of New or Revised Recommended Section 304(a) Criteria for Incorporation into the Basin Plan as Water Quality Objectives

Preliminary Review

Los Angeles Regional Water Quality Control Board
March 2018

Table of Contents

1. Introduction

In October 2015, revisions to the federal Water Quality Standards (WQS) regulations at 40 C.F.R. Part 131 went into effect. The final rule addressed certain key WQS program areas including triennial reviews pursuant to Clean Water Act (CWA) section 303(c)(1). Per the final rule, during their next triennial review, states and authorized tribes are to consider for adoption as WQS new or updated CWA section 304(a) water quality criteria recommendations[a] published by the U.S. EPA since May 30, 2000.

As a first step towards addressing this direction, this document presents a preliminary review of the section 304(a) water quality criteria recommendations published by the U.S. EPA since May 30, 2000, as well as the water quality objectives (WQOs) currently applied by the Los Angeles Water Quality Control Board (Los Angeles Water Board) for each of the 118 pollutants considered. The purpose of this document is not to make recommendations as to whether or not a recommended section 304(a) criterion ought to be addressed in the Basin Plan, but rather to present some background information on the pollutants, the recommended section 304(a) criteria, and the current regulatory status of these pollutants in the Los Angeles Region. Subsequent work will include an evaluation of which new or revised U.S. EPA criteria to consider for incorporation into the Basin Plan, and prioritization to determine in which order the selected criteria should be addressed.

2. Basin Plan Water Quality Objectives and their Regulatory Applications

Before discussing in detail U.S. EPA's water quality criteria recommendations, it is useful to review the water quality objectives contained in the Region's Basin Plan and their use as regulatory tools.

In general, water quality objectives are incorporated into the Basin Plan as either:

1) Specific numeric objectives, including in some cases site-specific objectives (*e.g.*, ammonia, copper, lead, chloride);

2) Maximum contaminant levels (MCLs) specified in Title 22 of the California Code of Regulations, incorporated by reference and meant to protect waters designated as Municipal and Domestic Water Supply (MUN);

---

[a] Section 304(a)(1) of the Clean Water Act (CWA) requires U.S. EPA to develop and publish, and from time to time revise, recommended criteria for the protection of water quality that accurately reflect the latest scientific knowledge. U.S. EPA's recommended section 304(a) criteria provide technical information for states and authorized tribes to consider and use in adopting water quality standards that ultimately provide the basis for assessing water body health and controlling discharges of pollutants into waters of the United States.

3) California Toxics Rule (CTR) criteria, set forth in 40 C.F.R. section 131.38, and incorporated by reference. The CTR contains federally promulgated water quality criteria applicable to California waters for 126 priority pollutants for the protection of aquatic life and human health;

4) Narrative objectives (e.g., "*All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life"*).

The WQOs are applied to protect beneficial uses in the Region's waters through their use in identifying impaired waters per CWA section 303(d), developing Total Maximum Daily Loads (TMDLs) and associated waste load allocations (WLAs), and setting effluent limits in National Pollution Discharge Elimination System (NPDES) permits, CWA section 401 water quality certifications, waste discharge requirements (WDRs) and waivers of WDRs. In general, their application depends on the waters considered (e.g., inland surface waters vs. ocean waters) and on the existing and designated beneficial uses (BUs) to be protected.[b]

- For inland surface waters[c]:
    - In order to protect aquatic life BUs, the applicable objectives include the CTR criteria for aquatic life and other WQOs as included in the Region's Basin Plan and other statewide water quality control plans[d] (such as toxicity, temperature, dissolved oxygen). Note that all of the surface waters in the region have some type of aquatic life beneficial use (WARM[e], COLD[f], MIGR[g], EST[h], etc.).

[b] Note that while the Basin Plan also addresses groundwater protection and includes water quality objectives applicable to groundwater, these are not addressed in this appendix because U.S. EPA does not make water quality criteria recommendations under CWA section 304(a) for groundwater protection.

[c] Inland surface waters are defined here as inland streams, lakes, enclosed bays, estuaries, and coastal lagoons.

[d] Statewide water quality control plans that address inland surface waters, including enclosed bays and estuaries, are the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California (ISWEBE), the Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality, and the Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (California Thermal Plan).

[e] Warm Freshwater Habitat (WARM): Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

[f] Cold Freshwater Habitat (COLD): Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

[g] Migration of Aquatic Organisms (MIGR): Uses of water that support habitats necessary for migration, acclimatization between fresh and salt water, or other temporary activities by aquatic organisms, such as anadromous fish.

[h] Estuarine Habitat (EST): Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).

- In order to protect human health BUs (MUN, COMM[i], SHELL[j], REC-1[k]), the applicable objectives include the CTR criteria for human health, MCLs specified in Title 22 of the California Code of Regulations, and other WQOs as included in the Region's Basin Plan and other statewide water quality control plans (e.g., bacteria). Note that although some surface waters in the region are not designated as MUN, water quality requirements to protect the MUN use may be necessary to protect surface waters that replenish groundwater with a designated MUN use.

- For ocean waters[l], the applicable objectives are contained in the Water Quality Control Plan for Ocean Waters of California (California Ocean Plan). Objectives are applied based on the existing and designated BUs of the ocean waters as identified in the Region's Basin Plan. The CTR criteria are not applicable to ocean waters as they are intended for California inland surface waters, bays and estuaries.
- Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

The Los Angeles Water Board has the authority to incorporate new or updated WQOs into its Basin Plan as needed to adequately protect beneficial uses. However, for pollutants that are part of the CTR, further action by the U.S. EPA to de-promulgate the CTR criterion may be necessary in situations where the updated WQO is less stringent than the CTR criterion. Modifications to WQOs in statewide water quality control plans are within the State Water Board's authority; therefore, the Los Angeles Water Board is not addressing the application of new or updated section 304(a) criteria to ocean waters.

The following sections describe briefly the pollutants and the corresponding section 304(a) water quality criteria recommendations published by the U.S. EPA since May 30, 2000 that are part of this review, as well as the current objectives for the pollutants as set forth in the Region's Basin Plan or the CTR.

---

[i] Commercial and Sport Fishing (COMM): Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

[j] Shellfish Harvesting (SHELL): Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes.

[k] Water Contact Recreation (REC-1): Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

[l] Ocean waters are the territorial marine waters of the State as defined by California law to the extent these waters are outside of enclosed bays, estuaries, and coastal lagoons.

3. Section 304(a) Water Quality Criteria Recommendations for the Protection of Human Health

3.1. Antimony

Chemical Abstracts Service Registry Number: 7440-36-0

Synonyms: Sb

General Information[1,2]**:** Antimony is a silvery-white, brittle metal found in the earth's crust and used mostly for industrial applications, usually as a powder. Alloys formed with copper, lead and tin are used to produce lead storage batteries, solder, sheet and pipe metal, bearings, castings, type metal, ammunition and pewter. Antimony oxide can be used as a flame retardant in textiles and plastics. It is also used in paints, ceramics, and fireworks, and as enamels for plastics, metal and glass. In addition, some forms of antimony have been used as medicine. Antimony is flammable and burns with intense heat, releasing potentially toxic fumes as it burns. It can react violently or explosively with contact with water, sparks, acids, and halogens.

Mining and processing of antimony-containing ores represent the main anthropogenic sources of antimony in the environment as well as the production of antimony metal, alloys, and oxide, and combinations of antimony with other substances. Antimony has not been mined in the United States since 2001, and most of it is imported from other countries, primarily China, for processing. However, antimony can be produced as a by-product of smelting lead and other metals. Overall, antimony levels in natural waters and soils tend to be very low, except in areas affected by mining. Antimony tends to adsorb strongly to soils and suspended particles and is not very mobile in soils unless biotransformed into a more mobile form by microbes. Antimony exists in multiple forms and combinations when in the environment, each with different degradation pathways. However, all versions of antimony tend to be persistent in the environment.

Long-term exposure to antimony can affect lung, heart and gastrointestinal functions. Exposure to high levels in the water are associated with vomiting, diarrhea, abdominal pain and ulcers. Exposure routes for humans are inhalation of antimony dust or fumes, ingestion of contaminated water or food, and dermal contact. Contact with the skin and eyes causes irritation and pain while inhalation irritates the respiratory tract. The cardiovascular system and respiratory system are the most significantly affected organs. The U.S. Department of Health and Human Services (DHHS) and the U.S. EPA have not classified antimony for cancer effects. However, according to the International Agency for Research on Cancer (IARC), antimony trioxide is possibly carcinogenic to humans and antimony trisulfide is not classifiable as to its carcinogenicity. It is a toxic, long-term hazard to aquatic life but has not been shown to bioaccumulate in organisms in any significant way.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria as well as current applicable WQOs are shown in the Table below. The Basin Plan contains the

Maximum Contaminant Level (MCL) for antimony specified in Table 64431-A of Section 64431 of Title 22 of the California Code of Regulations for the protection of MUN beneficial uses. The CTR criteria for human health is also incorporated by reference in the Basin Plan. In addition, the Basin Plan contains a narrative Toxicity WQO that applies to toxic substances in general. The State Water Board Ocean Plan includes a water quality objective for antimony applying to the consumption of fish collected in ocean waters.

Table 1: Updated U.S. EPA Human Health Water Quality Criteria as well as current applicable WQOs for Antimony

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	5.6
	Organism Only (µg/l)	640
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	14
	Organism Only (µg/l	4300
MCL	**(µg/l)**	6
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	**Organism only (µg/l)**	1200
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.
**"The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.2. Benzene

Chemical Abstracts Service Registry Number: 71-43-2

Synonyms: benzol, benzole, cyclohexatriene

General Information[3,4]**:** Benzene is a highly flammable, colorless aromatic liquid with a gasoline-like odor that evaporates quickly into the air and dissolves slightly in water. It is widely used in the United States as part of the process to make plastics, rubber, resins, detergents, explosives, varnish and synthetic fabrics. It is also use as a solvent in printing, paints, dry cleaning, etc. Benzene is also found in crude oils, the by-product of crude oil and coal refining, gasoline, and cigarette smoke. Benzene also occurs naturally in the smoke resulting from volcanos and forest fires.

Benzene will float in water due to its lower density but the vapor form will sink in air due to its higher density than ambient air. Benzene volatizes easily and the resultant mixture of vapors and air is explosive. This chemical will also reacts violently when exposed to oxidants and halogens. Benzene is rapidly degraded in the air by hydroxyl radical with a half-life of a few days to hours, but can travel long distances before being deposited on surface water and soils (and subsequently groundwater) by rain and snow. Once there, it will volatilize back to air or may be degraded by bacteria. Benzene does not tend to adsorb to the surrounding soil, making it very mobile in soils. Hydrolysis or photolysis of benzene is not expected, biodegradation under aerobic conditions being the primary degradation route in soils and water.

Because of its high volatility, the main source of human exposure to benzene is through inhalation. Waterborne and foodborne benzene contribute only a small percentage of the total daily intake in non-smoking adults. Exposure to benzene can lead to a variety of acute and long-term adverse health effects and diseases, including cancer and aplastic anemia. Aspiration of liquid benzene can be fatal and acute inhalation causes dizziness, drowsiness, headaches, possible unconsciousness, and serious irritation of the eyes, skin, and respiratory system. The U.S. EPA classifies benzene as a Category A chemical, meaning it is a known human carcinogen for all routes of exposure. Benzene particularly causes increased leukemia risk. Exposure to low levels of benzene is unavoidable for the general public due to how ubiquitous the chemical is in the environment, particularly the atmosphere. Benzene is not particularly toxic to aquatic organisms and is not likely to accumulate in plants or animals.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria as well as current applicable WQOs are shown in the Table below. The Basin Plan contains the Maximum Contaminant Level (MCL) for benzene specified in Table 64444-A of Section 64444 of Title 22 of the California Code of Regulations for the protection of MUN beneficial uses. The CTR criteria for human health is incorporated by reference in the Basin Plan. In addition, the Basin Plan contains a narrative Toxicity WQO that applies to toxic substances in general. The State Water Board Ocean Plan also includes a water quality objective for benzene applying to the consumption of fish collected in ocean waters.

Table 2: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for Benzene.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	0.58 - 2.1
	Organism Only (µg/l)	16 - 58
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	1.2
	Organism Only (µg/l)	71
MCL	**(µg/l)**	1
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	**Organism only (µg/l)**	5.9
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where

necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.
**"The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.3. Bis(chloromethyl) ether

Chemical Abstracts Service Registry Number: 542-88-1

Synonyms: BCME; Dichlorodimethyl ether; Chloromethyl ether

General Information[5,6,7]**:** Bis(chloromethyl) ether (BCME) is a synthetic, clear liquid with a strong, unpleasant odor that evaporates readily into the air and dissolves easily in water. BCME is highly flammable and mixtures of air and BCME vapor are explosive. In the past, it was used to produce polymers, resins, and textiles, but its use is now highly restricted and only small amounts are presently used inside fully enclosed systems in chemical plants. Production of BCME in the United States was greatly reduced after 1974 due to stringent regulation by OSHA and BCME is no longer commercially produced in the United States. Some BCME can also form as an impurity during the production of other chemicals. It is now primarily used as a research chemical and lab reagent.

BCME enters the environment generally as a vapor; no releases to water and soil have been reported by facilities allowed to process the chemical. BCME undergoes hydrolysis very quickly when exposed to water, so any leak into water or moist soil would be destroyed within a few minutes. BCME escaping to the air will also be broken down within a few hours by reacting with free hydroxyl radicals or water in the atmosphere. As such, toxicity to aquatic organisms is low and bioconcentration does not have enough time to occur.

Acute exposure to BCME may cause skin, mucous membrane, and respiratory tract irritation, while chronic exposure through inhalation is linked to chronic bronchitis, chronic cough, and impaired respiratory function. Acute exposure to even small quantities, particularly through inhalation, can result in death or permanent injury. Increased incidences of lung cancer have been observed among exposed workers, and the U.S. Department of Health and Human Services, U.S. EPA, and the IARC have concluded that BCME is carcinogenicity Classification A, a confirmed human carcinogen. Risk of exposure to BCME for the general public is low due to its rapid environmental degradation.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria are shown in the Table below. While the Basin Plan does not include specific human health objectives for bis(chloromethyl)ether, it is addressed by the narrative toxicity objective that applies to toxic substances in general. The Ocean Plan does not contain a numeric water quality objective for bis(chloromethyl)ether. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

Table 3: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for Bis(chloromethyl)ether.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	0.00015
	Organism Only (µg/l)	0.017
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	-
	Organism Only (µg/l)	-
MCL	**(µg/l)**	-
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	**Organism only (µg/l)**	-
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.
**"The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.4. Chloroform

Chemical Abstracts Service Registry Number: 67-66-3

Synonyms: Trichloromethane; Freon 20; a trihalomethane (THM)

General Information[8,9]: Chloroform is a colorless, volatile, liquid derivative of trichloromethane with an ether-like, nonirritating odor. Primarily an inhaled anesthetic for surgery, its use was banned in the U.S. due to its suspected carcinogenicity. Currently, chloroform is used in industry and as a laboratory solvent. The vast majority of U.S.-produced chloroform is used as a solvent in manufacturing the refrigerant Freon and chlorodifluoromethane, commonly used as a propellant and refrigerant. The rest is produced for export and miscellaneous uses. Chloroform is generally nonflammable and noncombustible, but can burn at very high temperatures and will release potentially toxic fumes when burned. Chloroform does occur naturally by being produced by some species, such as the red tropical algae.

Chloroform enters the environment primarily through industrial waste or as an indirect byproduct of water chlorination, municipal sewage, and cooling water from power plants. It may enter water and soil from spills and by leaks from storage and waste sites. Chloroform has many ways into the environment, so small amounts are likely to be found almost everywhere. Chloroform volatizes very quickly when exposed to air and dissolves easily in water. It does not bind to the soil very well and tends to be mobile in soils, potentially leaching down to groundwater where it can enter water supply. Chloroform persists for a long time in both the air and groundwater. Most chloroform in the air very slowly degrades into other chemicals, like phosgene (more toxic) and hydrogen chloride, over a 150-day half-life by reacting with hydroxyl radicals. Some chloroform may break down in soil via anaerobic biodegradation; no evidence of aerobic degradation has been confirmed.

The primary exposure route for the general public is through drinking water and beverages made with chloroform-impacted water, skin contact with chloroform-impacted water, and inhalation of chloroform vapor. Chloroform affects the central nervous system, liver, and kidneys after a person breathes air or drinks liquids that contain large amounts of chloroform, damaging those organs if chronically exposed. Breathing about 900 parts of chloroform in a million parts of air (900 ppm) for a short time causes fatigue, dizziness, and headache. Large amounts of chloroform touching the skin can cause painful irritation or sores. Acute chloroform toxicity results in impaired liver function, cardiac arrhythmia, nausea and central nervous system dysfunction. Results of studies of people who drank chlorinated water showed a possible link between the chloroform in chlorinated water and the occurrence of colon or urinary cancer. Liver and kidney tumors developed in rats and mice that chronically consumed food or water containing large amounts of chloroform, but human carcinogenicity from ingestion is not well established. Based on animal studies, the DHHS and the U.S. EPA determined that chloroform is a probable human carcinogen. IARC has determined that chloroform is possibly carcinogenic to humans (Group 2B). Chloroform does not appear to bioaccumulate to any significant levels in plants and animals but it is highly toxic to aquatic organisms and can persist in aquatic environments long enough to cause long-term adverse effects.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria as well as current applicable WQOs are shown in the Table below. While the Basin Plan does not include specific human health objectives for chloroform, it is addressed by the narrative toxicity objective that applies to toxic substances in general. In addition, although it is not part of Title 22 of the California Code of Regulations, the U.S. EPA provides a Primary MCL for chloroform. The State Water Board Ocean Plan also includes a water quality objective for chloroform applying to the consumption of fish collected in ocean waters.

Table 4: Updated U.S. EPA Human Health Water Quality Criteria and currently applicable WQOs for Chloroform.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	60
	Organism Only (µg/l)	2000
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	-
	Organism Only (µg/l)	-
MCL	**(µg/l)**	(80)*
Narrative Toxicity Objective**		

California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	Organism only (µg/l)	130
Narrative Objective†		

*Not referenced in the Basin Plan

** "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

† "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.5. Chlorophenoxy Herbicide 2,4-D

Chemical Abstracts Service Registry Number: 94-75-7

Synonyms: 2,4-Dichlorophenoxyacetic acid, 2,4-D, Monosan

General Information[10,11,12,13]**:** Chlorophenoxy herbicide 2,4-D (2,4-D) is among the most commonly used pesticides in the non-agricultural sector and one of the top ten most commonly used pesticides in the agricultural sector. It is a synthetic chemical often used as either a white to yellow, crystalline powder without an odor or a clear brown to black liquid with a phenoxy odor. It is noncombustible but can release potentially toxic fumes when burned. The acid itself is used as an herbicide specifically targeting broad-leafed weeds with little effect on grasses, but 2,4-D is an active ingredient in nine commercial products. The vast majority of global usage is due to two of these products: dimethyl amine salt and ethyhexyl ester. 2,4-D is infamous for being one of the two ingredients in Agent Orange.

2,4-D can be released into the air when it is being applied to weeds and can be released when manufactured. 2,4-D in the air can be broken down by other chemicals or can settle to the ground. 2,4-D's half-life in the atmosphere is roughly 19 hours as it reacts with hydroxyl radicals in the air. The primary degradation route is biotransformation by microbial activity. 2,4-D is not persistent in most soils with a half-life in soils of about 6 days under aerobic conditions (environments where oxygen is present) but longer under anaerobic (environments where there is limited oxygen) conditions. Although some of the 2,4-D in soil can go through the soil and enter the groundwater, it is rarely detected in groundwater. 2,4-D can enter rivers, lakes, and ponds from runoff and soil erosion when 2,4-D is sprayed on nearby plants or when it is used on water plants. It breaks down more slowly in water than in the air or in soil. It takes about 15 days to break down half of the 2,4-D in water under aerobic conditions and about 41–333 days under anaerobic conditions. According to the U.S. Geological Survey (USGS), 2,4-D is one of the 25 most frequently detected pesticides in U.S. waters.

It does not appear that contact with small amounts of 2,4-D will cause harmful effects in humans based on currently available scientific evidence. Exposure to high concentrations through skin contact causes irritation but acute exposure through ingestion causes burning abdominal pain, headache, vomiting, and unconsciousness. Inhalation exposure causes headaches, nausea, weakness, and a sore throat. Chlorophenoxy compounds such as 2,4-D are quickly absorbed when swallowed, but absorption from dermal or inhalation exposure is low. 2,4-D targets the cardiovascular, gastrointestinal, musculoskeletal, respiratory, and nervous systems, causing systemic irritation, endocrine disruption, neurotoxicity, and reproductive/developmental problems. Most harmful effects were seen on animals when they were given 2,4-D doses that were much higher than people would come in contact with in the environment. The U.S. EPA has determined that 2,4-D is not classifiable as to human carcinogenicity (Group D). This means that there was not adequate data either to support or refute human carcinogenicity. IARC recently classified 2,4-D as possibly carcinogenic to humans (Group 2B) based on "inadequate evidence" in humans and "limited evidence" in experimental animals. 2,4-D is extremely toxic to aquatic life and causes adverse long-term effects, though 2,4-D is not likely to bioconcentrate in fish.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria as well as current applicable WQOs are shown in the Table below. The Basin Plan contains the Maximum Contaminant Level (MCL) for Chlorophenoxy Herbicide 2,4-D specified in Table 64444-A of Section 64444 of Title 22 of the California Code of Regulations for the protection of MUN beneficial uses. In addition, it contains a narrative Toxicity WQO that applies to toxic substances in general. The Ocean Plan does not contain a numeric water quality objective for this chemical. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

Table 5: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for Chlorophenoxy Herbicide 2,4-D.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	1300
	Organism Only (µg/l)	12000
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	-
	Organism Only (µg/l)	-
MCL	**(µg/l)**	70
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	**Organism only (µg/l)**	-
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

**"The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.6. Chlorophenoxy Herbicide (2,4,5-TP) [Silvex]

Chemical Abstracts Service Registry Number: 93-72-1

Synonyms: 2,4,5-Trichlorophenoxypropionic acid; Silvex; 2 (2,4,5-Trichlorophenoxy) propionic acid, fenoprop

General Information[14,15]**:** Silvex is a hormonal herbicide belonging to the class of phenoxy herbicides, which includes 2,4-D and 2,4,5-T. In 1979 the U.S. EPA placed restrictions on the use of Silvex and 2,4,5-T. By 1985, all registrations of these herbicides in the U.S. were cancelled. Silvex is a solid at room temperature, usually a white powder with little odor. The acid is slightly corrosive and will release potentially toxic fumes when heated to decomposition despite being essentially nonflammable and noncombustible.

Silvex is insoluble in water and is not expected to volatize into a vapor. Silvex adsorbs strongly to soil and biodegrades in soil over a period of weeks to months. It is stable in water, from which it adsorbs strongly to sediments and suspended particles. Despite the ban on Silvex use in the United States, according to a 1992 report, it continues to enter the environment through leachates from municipal landfills. Despite its strong adsorption tendency and insolubility in water, it has the potential to be mobile enough in soils to enter the groundwater, especially if the soils are sandy or clay. Silvex is biodegraded in soil, with half-lives ranging from 8 to 290 days depending on soil makeup and if the conditions are aerobic or anaerobic. While it does not readily volatize, Silvex can exist in the ambient air as both vapor and particulate, reacting with naturally occurring hydroxyl radicals and degrading quickly with a half-life of about 35 hours.

A limited database exists concerning the toxicity of silvex in mammals. Subchronic and chronic studies in rats and dogs indicate that the kidneys and liver are the most sensitive organs. Carcinogenicity studies in rats and mice were negative, although there were serious deficiencies in the study protocols. In addition, Silvex was non-mutagenic in the Ames test. The carcinogenicity of Silvex in human populations has only been studied by association with other, more commonly used chlorophenoxy herbicides, i.e., 2,4-D and 2,4,5-T, but results have been inconclusive. Silvex is a Classification D chemical, meaning it is not expected to be carcinogenic. Silvex is highly toxic to aquatic organisms with moderate capacity for bioconcentration and it can persist for long periods of time in water due to its insolubility.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria as well as current applicable WQOs are shown in the Table below. The Basin Plan contains the Maximum Contaminant Level (MCL) for Silvex specified in Table 64444-A of Section 64444 of Title 22 of the California Code of Regulations for the protection of MUN beneficial uses. In addition, it contains a narrative Toxicity WQO that applies to toxic substances in general. The Ocean Plan does not contain a numeric water quality objective for this chemical. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: “The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health.”

Table 6: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for Silvex.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	100
	Organism Only (µg/l)	400
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	-
	Organism Only (µg/l)	-
MCL	**(µg/l)**	50
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	**Organism only (µg/l)**	-
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.
**"The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.7. Cyanide

Chemical Abstracts Service Registry Number: 57-12-5

Synonyms: CN-; HCN; Hydrogen cyanide

General Information[16,17,18]: Cyanide refers to a group of chemicals characterized by a carbon atom triple bonded to a nitrogen atom. Cyanides can be both naturally-occurring or synthetic and can be found as either white crystals/powders or as aqueous solutions with a bitter almond odor. Most cyanides are highly toxic with some used as poisons or weaponized. Natural sources of cyanide can be produced by certain species of bacteria, fungi, and algae or be created as part of sugars or natural compounds in various foods and plants (e.g. almonds, soy, spinach, bamboo shoots, etc.), though the edible portions of these plants eaten in the United States contain low amounts of cyanide. Cyanides are non-combustible and nonflammable but release toxic, corrosive, or flammable fumes when heated to degradation.

Sources of cyanide as a pollutant in soil and water occur primarily from industrial water discharges, such as from metal mining, organic chemical industries, iron/steel plants, or wastewater treatment facilities. Cyanide can enter the air through vehicle exhaust, industrial releases, municipal waste burning, and pesticide use. Cyanide in landfills can leach down to contaminate groundwater. Hydrogen cyanide, sodium cyanide, and potassium cyanide are the most common forms of cyanide that enter the environment through anthropogenic means. Airborne cyanide, usually gaseous hydrogen cyanide but sometimes a fine dust, is rarely concentrated enough to cause concern. The dust can be removed from air by settling or precipitation events but the gaseous form is not easily removed and can have half-lives ranging from one to three years in the atmosphere. In surface water, most cyanide will volatize into gaseous hydrogen cyanide and the remainder will generally be biodegraded into less harmful chemicals by microorganisms, though this half-life is not established. Cyanides do not tend to bind strongly to soils and so tend to be quite mobile in soils. Cyanides in soils will tend to volatize into gaseous hydrogen cyanide or be biodegraded by microorganisms before leaching into groundwater. Groundwater contamination can and does occur, particularly when cyanides are highly concentrated enough to be toxic to the microorganisms that would break down the chemicals. Different forms of cyanide can be variably resistant to hydrolysis and photolysis.

The major exposure routes for the general public are inhalation of contaminated air or ingestion of contaminated foods or water, though the concentrations encountered are normally quite low. Tobacco smoke contains high levels of the less toxic thiocyanate. Dermal exposure rates are low and primarily affect people working with cyanide-containing compounds, causing skin irritation and sores. Workers are more at risk of cyanide inhalation. However, exposure to even small amounts of cyanide can be fatal, toxicity varying depending on the form of cyanide. Acute exposure to high levels of cyanide can cause brain and cardiovascular damage, coma, and death. Ingestion of cyanide compounds can result rapidly in death. Chronic inhalation of hydrogen cyanide causes breathing problems, chest pain, vomiting, blood changes, headaches, and enlargement of the thyroid gland. While generally highly poisonous, no evidence suggests that cyanide is an animal or human carcinogen. Cyanide is moderately to highly toxic to most aquatic species, especially fish and crustaceans, but slightly less toxic for mollusks.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria as well as current applicable WQOs are shown in the Table below. The CTR criteria for human health is incorporated by reference in the Basin Plan. The Basin Plan also contains the Maximum Contaminant Level (MCL) for cyanide specified in Table 64431-A of Section 64431 of Title 22 of the California Code of Regulations for the protection of MUN beneficial uses. In addition, the Basin Plan contains a narrative Toxicity WQO that applies to toxic substances in general. The Ocean Plan does not contain a numeric water quality objective for this chemical. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: “The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health.”

Table 7: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for Cyanide.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	4
	Organism Only (µg/l)	400
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	700
	Organism Only (µg/l)	220,000
MCL	**(µg/l)**	150
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	**Organism only (µg/l)**	-
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

**"The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.8. Dinitrophenols

Chemical Abstracts Service Registry Number: 25550-58-7

Synonyms: none

General Information[19,20]**:** Dinitrophenols are a class of synthetic organic chemicals that can exist in six individual forms. Dinitrophenols do not occur naturally in the environment. The most commercially important dinitrophenol is 2,4-dinitrophenol, also called DNP. Commercial DNP is primarily used for making dyes, other organic chemicals, and wood preservatives. It is also used to make photographic developer, explosives, and insect control substances. DNP exists as a yellow, orthorhomibic, crystalline solid at room temperature with a sweet, musty odor. DNP can explosively decompose when too dry, emitting toxic fumes (nitroxides) when heated to decomposition.

DNP is just slightly soluble in water and is not expected to volatize. DNP enters the air, water, and soil during its manufacture and use, particularly its former usage as a pesticide. It forms in the air when other pollutants react with oxides of nitrogen present in polluted air. Automobile exhaust also releases DNP into the air. Burning certain wastes also produces DNP. Wastes containing DNP that are generated during its manufacture and use are sometimes disposed in landfills where DNP enters the environment from these landfills. It also enters the environment from accidental spills during transport and leaks from storage containers. The primary degradation route in air is reactions with naturally-occurring hydroxyl radicals. It is somewhat susceptible to photolysis and biodegradation, depending on the characteristics of the environment. It is not expected to bind well to soils or suspended particles and thus is highly mobile in soils. While there will be some differences, the other less-studied dinitrophenols will likely follow a very similar general environmental fate as DNP.

Exposure routes for the general population are inhaling contaminated air, ingesting contaminated food or water, or less likely coming in contact with DNP-treated wood. Urban communities will likely be exposed to higher levels of dinitrophenols than rural communities due to the concentrated exhaust fumes. Brief or long-term exposure to DNP can cause increased basal metabolic rates (the rate that you use energy at complete rest); a feeling of warmth; sweating; weight loss; and increased heart rate, breathing rate, and body temperature; numbness in the hands and feet; decrease of certain types of white blood cells; cataract. Additionally, prolonged or chronic exposure to DNP can cause organ damage and acute exposure to high concentrations through ingestion or skin contact can be fatal due to pulmonary or cardiac collapse. No evidence suggests that DNP is a human or animal carcinogen. This chemical is extremely toxic to aquatic organisms, though it does not bioconcentrate significantly, and its persistence time in water has not been established.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria are shown in the Table below. While the Basin Plan does not include specific human health objectives for dinitrophenols, it is addressed by the narrative toxicity objective that applies to toxic substances in general. The Ocean Plan does not contain a numeric water quality objective for dinitrophenols. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: “The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health.”

Table 8: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for Dinitrophenols.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	10
	Organism Only (µg/l)	1000
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	-
	Organism Only (ug/l)	-
MCL	**(µg/l)**	-
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	**Organism only (µg/l)**	-
Narrative Objective**		

* “All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life….” Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region’s Basin Plan or statewide water quality control plans such as the California Ocean Plan.

**"The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.9. Hexachlorocyclohexane (HCH)-Technical or Technical-BHC

Chemical Abstracts Service Registry Number: 608-73-1

Synonyms: technical-Benzene hexachloride; technical-Hexachlorocyclohexane

General Information[21,22]: Hexachlorocyclohexane (HCH) is a manufactured, entirely synthetic chemical that exists in eight chemical forms called isomers. One of these forms, gamma-HCH (or γ-HCH, commonly called lindane) is produced and used as an insecticide on fruit, vegetables, and forest crops. It is also available as a prescription (lotion, cream, or shampoo) to treat head and body lice, and scabies. Lindane has not been produced in the United States since 1976, but is imported for insecticide use. Lindane is a white to yellow crystalline powder that has a musty odor. It tends to be stable in acids but becomes unstable in alkaline conditions. It is not flammable but will release toxic fumes (HCl) when heated to decomposition. Technical-grade HCH was used as an insecticide in the United States and typically contained 10-15% gamma-HCH as well as the alpha (α), beta (β), delta (δ), and epsilon (ε) forms of HCH. Virtually all the insecticidal properties resided in gamma-HCH. Technical-grade HCH has not been produced or used in the United States in over 20 years.

Though HCH is no longer produced in the United States, use of imported HCH remains a vector for HCH entering the environment. Additionally, HCH is very persistent in the environment and remains detectable from historical production and application, agricultural spraying being the primary route for vapor HCH to enter the environment. The components of technical-grade HCH have been found in soil and surface waters near hazardous waste sites. Once released into the environment, HCH can move through and persist in all environmental media. In the air, the different forms of HCH can exist as a vapor or attached to small particles such as soil and dust. The particles may be removed from the air by rain or degraded by other compounds in the atmosphere such as hydroxyl radicals. HCH has a long persistence time in the air and can travel great distances. In soil, sediments, and water, biodegradation is the primary decomposition process. HCH is broken down to less toxic substances by algae, fungi, and bacteria, but this process can take a long time and are very dependent on ambient conditions. HCH generally is not very mobile in soils but can leach into groundwater.

Exposure risk for the general population has been significantly decreased due to the bans on technical HCH manufacturing and usage, but individuals living near hazardous waste sites may still be potentially exposed to risky levels. The U.S. EPA classifies HCH as in carcinogen Classification B2 and Group A3, meaning that it is a probable human carcinogen with confirmed carcinogenicity in animals but inadequate data for human carcinogenicity. Exposure to high levels of HCH can cause blood disorders, dizziness, headaches, seizures, and changes in the levels of sex hormones. Short-term exposure can result in skin, eye, and respiratory irritation. HCH is highly toxic to aquatic organisms and its long persistence times increase the risk of long-term exposure for sensitive species. HCH can bioaccumulate to high levels in many aquatic organisms, for example accumulating in the fatty tissues of fish. HCH seems to bioaccumulate only at limited levels for plants and terrestrial organisms and does not biomagnify up the food chain in terrestrial ecosystems at anywhere near the biomagnification in aquatic ecosystems.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria are shown in the Table below. While the Basin Plan does not include specific human health objectives for HCH, it is addressed by the narrative toxicity objective that applies to toxic substances in general. The Ocean Plan does not contain a numeric water quality objective for HCH. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

Table 9: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for HCH.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	0.0066
	Organism Only (µg/l)	0.01
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	-
	Organism Only (µg/l)	-
MCL	**(µg/l)**	-
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	**Organism only (µg/l)**	-
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

**"The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.10. Methylmercury

Chemical Abstracts Service Registry Number: 22967-92-6

Synonyms: Mercury, methyl; MeHg, methylmercury ion, methylmercury II

General information[23,24]: Mercury (Hg) is negatively impacting the beneficial uses of many waters of the state by making fish unsafe for human and wildlife consumption due to bioaccumulation and biomagnification of methylmercury. Mercury converts to methylmercury when released into fresh or marine water due to being processed from inorganic Hg to MeHg. The vast majority of methylmercury exists due to the methylation of inorganic mercury. Although mercury occurs naturally in the environment, usually due to biological activity, concentrations of mercury often exceed background levels because of human activities. Gold and mercury mines and atmospheric deposition are the predominate sources of mercury, with minor contributions from industrial and municipal wastewater discharges and urban run-off.

Mercury and methylmercury are both expected to be found in water and soil because they are both produced and destroyed by microbial activity. Methylmercury is soluble in water at low concentrations. Methylmercury will not volatize as it is a cation and cations are incapable of evaporating. Methylmercury is primarily removed from the environment through microbial degradation or by bioaccumulation through significant water-exposure (e.g. fish) or through the food chain, lasting up to three years in animal tissues.

The primary route of exposure for humans is ingestion of contaminated seafood as methylmercury can bioaccumulate in aquatic organisms to dangerous levels. Methylmercury is a carcinogen Classification C chemical, meaning it is a possible human carcinogen with inadequate human and animal test data. Potential effects include dose-dependent severe neurological damage and even death. It has dangerous developmental effects for fetuses, interfering with proper neuron growth. All forms of mercury are known to be toxic to the kidneys. Methylmercury is somewhat toxic to aquatic organisms in high concentrations but bioaccumulates very readily.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria are shown in the Table below. While the Basin Plan does not include specific human health objectives for methylmercury, it is addressed by the narrative toxicity objective that applies to toxic substances in general. However, in 2017, the State Water Board adopted Mercury provisions as Part 2 of the statewide Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California (ISWEBE) (Resolution 2017-0027). The resolution sets mercury limits to protect the beneficial uses associated with the consumption of fish by both people and wildlife.

The Ocean Plan also does not contain numeric water quality objectives for methylmercury. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: “The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health.”

Table 10: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for Methylmercury.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (mg/kg)**	-
	Organism Only (mg/kg)	0.3
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	-
	Organism Only (µg/l)	-
MCL	**(µg/l)**	-
Narrative Toxicity Objective §		
Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California †		
Sport Fish Objective*	**Organism Only (mg/kg)**	0.2 within a calendar year
Tribal Subsistence Fishing**	**Organism Only (mg/kg)**	0.04 within a calendar year
Subsistence Fishing Objective		Waters free of mercury at concentrations which accumulate in fish and cause adverse biological, reproductive, or neurological effects in people
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	**Organism only (mg/kg)**	-
Narrative Objective ±		

§ "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

* The objective applies to the wet weight concentration in skinless fillet in trophic level 3 or trophic level 4 fish, whichever is the highest trophic level fish in the water body.

** The objective applies to the wet weight concentration in skinless fillet from a mixture of 70 percent trophic level 3 fish and 30 percent trophic level 4 fish

† The State Water Board also adopted methylmercury objectives for the protection of aquatic life, including:

Prey Fish Objective[i]	Organism Only (mg/kg)	0.05 during the breeding season
California Least Tern Prey Fish Objective[ii]	Organism Only (mg/kg)	0.03 from April 1 through August 31

[i] The objective applies to the wet weight whole fish tissue of any species between 50 to 150 mm in total length during the breeding season.

[ii] The objective applies to the wet weight concentration in whole fish less than 50 mm total length.

± "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.11. Methoxychlor

Chemical Abstracts Service Registry Number: 72-43-5

Synonyms: DMDT, Marlate, Metox

General information[25,26,27]: Methoxychlor is an insecticide developed as a replacement for DDT. It is effective against a wide range of pets including biting flies, houseflies, mosquito larvae, cockroaches, and chiggers. It was used on field crops, vegetables, fruits, stored grains, livestock, pests, homes, gardens, lakes, and marshes. All products were suspended in 2000.

Methoxychlor occurs as white to pale yellow crystalline solids, often powdered, with a slightly fruity odor. It is practically insoluble in water but is often dissolved in a liquid carrier, such as diesel oil or alcohol. Methoxychlor's vapor pressure is effectively negligible so it is not expected to volatize. It will release toxic gases (e.g. HCL or carbon monoxide) when heated to decomposition. Methoxychlor strongly binds to soil particles and so has low mobility by itself, though contaminated soil particles can be carried by runoff or wind. In aquatic environments, methoxychlor will bind to suspended sediments or organic matter and sink. Methoxychlor can photodegrade in natural water within a matter of hours, though the same process took months in laboratory testing with distilled water. In soils and sediments, methoxychlor can be biodegraded in both aerobic and anaerobic conditions, though anaerobic biodegradation seems to be faster.

Chronic oral exposure to methoxychlor has resulted in effects to the liver, kidneys, body weight and nervous system. Methoxychlor and its metabolites possess estrogenic properties. Reproductive and developmental effects are the primary concern from methoxychlor exposure. Animal studies have reported developmental and reproductive effects, such as abortions, reduced fertility, reduced litter size, and skeletal effects from oral exposure to methoxychlor. Health hazard to humans is relatively low, inhalation or ingestion exposure causing generalized depression and dermal exposure causes some irritation. The U.S. EPA has classified methoxychlor as a group D, not classifiable as to human carcinogenicity, based on the fact that human data are unavailable and animal evidence is inconclusive.

The primary hazard of methoxychlor is the threat to the environment. If dissolved in a liquid carrier, it can easily penetrate the soil and contaminate groundwater and nearby systems. It is very toxic to aquatic life and can bioaccumulate in some organisms, like fish and mollusks. However, methoxychlor is broken down metabolically and so does not biomagnify up the food chain.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria as well as current applicable WQOs are shown in the Table below. The Basin Plan contains the Maximum Contaminant Level (MCL) for methoxychlor specified in Table 64444-A of Section 64444 of Title 22 of the California Code of Regulations for the protection of MUN beneficial uses. In addition, the Basin Plan contains a narrative Toxicity WQO that applies to toxic substances in general. The Ocean Plan also does not contain numeric water quality objectives for this chemical. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

Table 11: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for Methoxychlor.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	0.02
	Organism Only (µg/l)	0.02
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	-
	Organism Only (µg/l)	-
MCL	**(µg/l)**	30
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	**Organism only (µg/l)**	-
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

** "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.12. Nitrosodibutylamine, N

Chemical Abstracts Service Registry Number: 924-16-3

Synonyms: Butylamine, N-Nitrosodi; N-Butyl-N-nitroso-1-butamine; DBN; DBNA; Dibutylamine, N-Nitroso; Dibutylnitrosamine; Di-*n*-butylnitrosamine; N,N-Di-*n*-butylnitrosamine; NDBA; N-Nitroso-di-*n*-butylamine

General information[28,29,30]: N-Nitrosodibutylamine is a pale yellow, oily liquid that is not produced commercially but rather forms as a waste product from rubber manufacturing and metal working factories. This chemical is relatively stable in neutral or alkaline solutions but slowly degrades in acidic solutions and reacts with strong oxidizing agents. It will release potentially toxic fumes (nitrogen oxide) when heated to decomposition.

N-Nitrosodibutylamine most often enters the environment through industrial waste streams but can also be formed in soils, water, and sewage through the addition of significant amounts of nitrite and amines (secondary or tertiary). It is somewhat soluble in water and organic solvents. It is expected to volatize from water and wet soil surfaces but not from dry soil surfaces. If it is released as a vapor, it will remain in the vapor form where it has a half-life of about 1.4 hours as hydroxyl radicals degrade it. Environmental biodegradation of this chemical is not well-studied but is considered to be a possible significant fate process in soil.

Human exposure routes for this chemical include inhalation or dermal contact at workplaces where this waste product is present. Exposure routes for the general population include inhalation of cigarette smoke, ingestion of contaminated food, and breathing the air inside new cars. While no data is available for humans, there is reasonable evidence of carcinogenicity in animals, causing increased incidences of several different types of tumors. Many chemicals in the family N-nitrosamines, including this chemical, are teratogenic, mutagenic, and carcinogenic. N-Nitrosodibutylamine is reasonably anticipated to be a human carcinogen and is a carcinogen Classification B2, meaning it is a probable human carcinogen. While this chemical is not particularly toxic to aquatic organisms, it has the potential for moderate bioconcentration in aquatic organisms, assuming the chemical is not altered upon release into the environment.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria are shown in the Table below. While the Basin Plan does not include specific human health objectives for N-Nitrosodibutylamine, it is addressed by the narrative toxicity objective that applies to toxic substances in general. The Ocean Plan also does not contain water quality objectives for N-Nitrosodibutylamine. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

Table 12: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for N-Nitrosodibutylamine.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	0.063
	Organism Only (µg/l)	0.22
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	-
	Organism Only (µg/l)	-
MCL	**(µg/l)**	-
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	**Organism only (µg/l)**	-
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.
** "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.13. Nitrosidiethylamine, N (NDEA)

Chemical Abstracts Service Registry Number: 55-18-5

Synonyms: Diethylnitrosamine; DEN; NDEA ; DANA, nitrous diethylamide

General information[31,32,33]: N-Nitrosodiethylamine is a synthetic clear to yellow oil that is soluble in water, lipids and other organic solvents. This chemical is used as a gasoline and lubricant additive, antioxidant, and stabilizer for industry materials. It is not produced commercially as an end product, rather it is used more experimentally or as a byproduct of other chemical industrial activities. It is volatile, light-sensitive, and combustible, releasing toxic fumes (nitrogen oxides) when heated to decomposition. It can be stabilized for several days in alkaline or neutral aqueous solutions but is significantly less stable when in strongly acidic solutions. It is incompatible with strong oxidizing or reducing agents.

N-Nitrosodiethylamine enters the environment primarily from waste streams related to its use in gasoline and lubricants and, in small concentrations, from cigarette smoke. It is expected to volatize from water and moist soils and will remain in the vapor form if released into the environment as a vapor, where it has a half-life of 22 hours as hydroxyl radicals in the air degrade it. It is highly susceptible to photolysis. It does not bind strongly to soil or suspended particles, causing this chemical to be highly mobile in soil. It is not readily biodegraded but there are a small handful of species that are capable of biotransforming this chemical, mostly anaerobically.

Occupational exposure routes are inhalation or dermal contact. Exposure routes for the general population are inhalation of cigarette smoke and auto interior air as well as ingestion of food and water containing the chemical. Contact with skin and eyes causes irritation and inhalation will irritate the respiratory tract. Nitrosodiethylamine affects DNA integrity, probably by alkylation, and is used in experimental research to induce liver tumorigenesis. N-Nitrosodiethylamine is considered in carcinogen Classification B2 and Group 2A, meaning it is a probable human carcinogen. There is little human carcinogenicity data but reasonable evidence of animal carcinogenicity, primarily inducing liver tumors. This chemical is highly toxic to marine organisms, though not acutely toxic, causing injury and mortality to amphibians, flatworms, zooplankton, and some fish. It also causes adverse effects on growth and genetics, though its potential for bioconcentration is low.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria are shown in the Table below. While the Basin Plan does not include specific human health objectives for N-Nitrosodiethylamine, it is addressed by the narrative toxicity objective that applies to toxic substances in general. The Ocean Plan also does not contain numeric water quality objectives for N-Nitrosodiethylamine. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: “The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health.”

Table 13: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for N-Nitrosodiethylamine.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	Water + Organism (µg/l)	0.0008
	Organism Only (µg/l)	1.24
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	Water + Organism (µg/l)	-
	Organism Only (µg/l)	-
MCL	(µg/l)	-
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	Organism only (µg/l)	-
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

** "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.14. Nitrosopyrrolidine, N

Chemical Abstracts Service Registry Number: 930-55-2

Synonyms: 1-nitrosopyrrolidine, NPYR

General information[34,35,36]: N-Nitrosopyrrolidine is a clear to yellow, oily liquid used in laboratory research to induce tumors in experimental animals. No evidence shows that it is produced as a commercial product. It is light-sensitive, decomposing when exposed to light, as well as flammable and combustible, releasing toxic fumes (nitrogen oxides) when heated to decomposition. It is soluble in organic solvents and lipids and miscible in water. This substance is present in tobacco smoke and may be formed during cooking of foods that contain sodium nitrite as a preservative, including meat, fish and cheese.

N-Nitrosopyrrolidine most commonly enters the environment from cigarette smoke, bacon-frying, wastewater discharges, and sewage sludge. It is not expected to volatize from water or soils but will remain in the vapor form if released into the environment as a vapor, where it has a half-life of roughly a day as hydroxyl radicals in the air degrade it. It is highly susceptible to photolysis. It does not bind strongly to soil or suspended particles, causing this chemical to be highly mobile in soil. It can be somewhat, but not completely, biodegraded by some specific microorganisms.

Exposure routes for the general population are inhalation of tobacco smoke and bacon-frying vapor as well as ingestion of certain foods, particularly cured meats and fish. Exposure to N-

Nitrosopyrrolidine irritates the skin and eyes and can damage the liver and kidneys. N-Nitrosopyrrolidine is a probable human carcinogen, falling into carcinogen Classification B2 and Group 2B. Evidence on potential carcinogenicity from animal studies is "Sufficient," and the evidence from human studies is "Inadequate." There is no evidence regarding toxicity to aquatic organisms and the potential for bioconcentration is low.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria are shown in the Table below. While the Basin Plan does not include specific human health objectives for N-Nitrosopyrrolidine, it is addressed by the narrative toxicity objective that applies to toxic substances in general. The Ocean Plan also does not contain numeric water quality objectives for N-Nitrosopyrrolidine. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

Table 14: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for N-nitrosopyrrolidine.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	Water + Organism (µg/l)	0.016
	Organism Only (µg/l)	34
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	Water + Organism (µg/l)	-
	Organism Only (µg/l)	-
MCL	(µg/l)	-
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	Organism only (µg/l)	-
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.
** "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.15. Pathogen and pathogen indicators

General Information[37,38,39]**:** Pathogens are disease-causing microorganisms that include bacteria, viruses, and protozoa, accounting for roughly 10 percent of the total number of known microorganism species. The primary infection vectors are contact with infected people or animals and consumption of contaminated food or water. Direct sources of pathogens in water are primarily from human, livestock, and wildlife waste. Indirect sources include sewage spills or overflows, illegal septic system connections, wastewater treatment facility discharges, urban stormwater systems, and runoff from agricultural, wildlife, or urbanized areas. Waterborne pathogens usually cause symptoms that include skin rashes, upper respiratory illness, headaches, fatigue, and gastrointestinal illness (e.g. diarrhea, nausea, vomiting), though other forms of water contamination can cause similar health problems. Major waterborne bacterial pathogens are often associated with fecal matter, including *E. coli* and *Campylobacter jejuni* (*C. jejuni*). The primary protozoan pathogens of concern are the parasitic *Cryptoporidium parvum* and the genus *Giardia*. Only a small percentage of the more than 100 different strains of viral pathogens that may be present in feces-contaminated waters are able to be monitored.

Traditionally, the presence of pathogens in water has been determined by the presence of indicator microorganisms because monitoring specific pathogenic microorganisms is often a difficult, lengthy, and expensive process that may not actually identify the pathogen of concer n. Though there is no direct correlation between the numbers indicator microorganisms and enteric pathogens, pathogenic organisms are difficult to screen for and thus the pathogen -indicator method is highly useful for determining if there is a risk of path ogen presence. There is no universal indicator but rather several more specific indicators broken down into three groups: process indicators, fecal indicators, and index/model organisms. Process indicators show the efficacy of a process (e.g. total coliforms for chlorine disinfection). Fecal indicators show the presence of fecal contamination (e.g. *E. coli* indicating the presence of animal fecal matter). Index and model organisms refer to a group or species that indicates pathogen presence and behavior, respectively (e.g. *E. coli* as an index for *Salmonella* presence). As both the pathogens and the indicator species are living organisms, their survival rates and overall capacity to be effectively monitored can vary widely depending on environmental conditions and the microorganisms' individual characteristics. The full effects of waterborne pathogens on the general population are poorly understood as most cases of gastrointestinal illness are unreported. However, 35 percent of all gastrointestinal illnesses are estimated to be due to waterborne pathogens.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria as well as current applicable WQOs are shown in the Table below. In addition, the table shows the State Water Board's proposed final statewide Bacteria Provisions as Part 3 of the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays and Estuaries of California (ISWEBE), and as amendments to the California Ocean Plan.

The proposed statewide Bacteria Provisions, if adopted, would apply to fresh, estuarine, and ocean waters, and would supersede numeric water quality objectives for the REC-1 beneficial use in the Los Angeles Water Board's Basin Plan established prior to the effective date of the Bacteria Provisions. Narrative water quality objectives and numeric site-specific objectives established before or after the effective date of the statewide Bacteria Provisions would remain in effect.

Table 15: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for Pathogen and Pathogen Indicators.

Updated EPA Human Health Water Quality Criteria				
Recommendation 1 (estimated illness rate 36/1000)	**Freshwater**	**E coli (cfu/100ml)**	30-day geometric mean	126
			Statistical threshold value*	410
		Enterococcus (cfu/100ml)	30-day geometric mean	35
			Statistical threshold value*	130
	Marine waters	**Enterococcus (cfu/100ml)**	30-day geometric mean	35
			Statistical threshold value*	130
Recommendation 2 (estimated illness rate 32/1000)	**Freshwater**	**E coli (cfu/100ml)**	30-day geometric mean	100
			Statistical threshold value*	320
		Enterococcus (cfu/100ml)	30-day geometric mean	30
			Statistical threshold value*	110
	Marine waters	**Enterococcus (cfu/100ml)**	30-day geometric mean	30
			Statistical threshold value*	110
Los Angeles Water Board Basin Plan				
Regional Objectives	**Freshwater with REC-1 designation**	**E coli (cfu/100ml)**	30-day geometric mean (minimum 5 samples)	126
			Single sample	235
	Freshwater with LREC-1 designation	**E coli (cfu/100ml)**	30-day geometric mean (minimum 5 samples)	126
			Single sample	576
	Marine waters with REC-1 designation	**Total coliform (cfu/100ml)**	30-day geometric mean (minimum 5 samples)	1,000
			Single sample	10,000
		Fecal coliform (cfu/100ml)	30-day geometric mean (minimum 5 samples)	200
			Single sample	400
		Enterococcus (cfu/100ml)	30-day geometric mean (minimum 5 samples)	35
			Single sample	104
	Waters with REC-2 designation (and no REC-1 designation)	**Fecal coliform (cfu/100ml)**	Concentration over 30-day period (minimum 4 samples)	2000
			10% of samples over 30-day period	4000
	Waters with SHELL designation	**Fecal coliform (cfu/100ml)**	30-day median concentration	70
			Value not to be exceeded by 10% of samples over 30-day period	230 (5-tube decimal dilution test) 330 (3-tube decimal dilution test)
MCL		**Total coliform (cfu/100ml)**	7-day median concentration	2.2 MPN**
			Value not to be exceeded in more than 1 sample in any 30-day period	23 MPN**

Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California *California Ocean Plan*				
Proposed Objectives for the protection of REC-1 (estimated illness rate 32/1000)	**Waters with salinity ≤1ppt 95% or more of the time**	**E. coli (cfu/100ml)**	6-week geometric mean	100
			Statistical threshold value†	320
	Waters with salinity >1ppt more than 5% of the time	**Enterococci (cfu/100ml)**	6-week geometric mean	30
			Statistical threshold value†	110

* Should not be exceeded by more than 10% of the samples taken over a 30-day interval.

** MPN stands for Most Probable Number

† Should not be exceeded by more than 10% of the samples collected in a single month's time.

3.16. Pentachlorobenzene

Chemical Abstracts Service Registry Number: 608-93-5

Synonyms: 1,2,3,4,5-Pentachlorobenzene; 608-93-5; Benzene, pentachloro-

General Information[40,41,42]: Pentachlorobenzene (PeCB) is a known persistent organic pollutant (POP), classified among the "dirty dozen" and banned globally in 2011 by the Stockholm Convention on Persistent Organic Pollutants. It is often encountered as colorless to white crystals with a pleasant odor. Past uses of PeCB are PeCB as a component in polychlorinated biphenyl (PCB) products, in dyestuff carriers, as a fungicide and a flame retardant and as a chemical intermediate, e.g. for the production of quintozene. Major U.S. and European manufacturers of quintozene have changed their manufacturing process to eliminate this use of PeCB. PeCB is also present at low levels as an impurity in several herbicides, pesticides and fungicides. In the United States, some pesticide manufacturers have changed their manufacturing processes to reduce the concentration of hexachlorobenzene (HCB) impurities in their products, and these changes may have reduced concentrations of PeCB contaminants also; PeCB is also a low level degradation product of some pesticides. Nowadays, PeCB enters the environment through various sources of which PeCB as a byproduct of incomplete combustion is the most important.

Pentachlorobenzene is fairly resistant to degradation other than photolysis and biodegradation, with higher organic matter significantly increasing persistence times. PeCB is insoluble in water and largely unreactive. It will tend to bind strongly to soil particles and thus has low mobility in soil. PeCB is expected to volatize from moist soils but its strong tendency to adsorb to soils decreases the amounts ultimately evaporated. Volatized or released PeCB vapor will degrade in the air by reacting with hydroxyl radicals. Its half-lives in all conditions range from about 200 – 345 days.

PeCB is moderately toxic to humans and is especially dangerous to pregnant women. Animal tests show that this substance possibly causes toxicity to human reproduction or development. The substance may have effects on the liver, resulting in liver impairment. PeCB is a Classification D chemical and is not considered to be a human carcinogen. It is combustible under specific conditions, releasing potentially toxic fumes when burned. Within the European

Union, PeCB is classified as a substance which is very toxic to aquatic organisms. Bioaccumulation of this chemical may occur in fish, in milk, in plants and in mammals. The substance may cause long-term effects in the aquatic environment. This substance may be hazardous to the environment; special attention should be given to its persistence in soil and its adsorption into sediments.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria are shown in the Table below. While the Basin Plan does not include specific human health objectives for pentachlorobenzene, it is addressed by the narrative toxicity objective that applies to toxic substances in general. The Ocean Plan also does not contain numeric water quality objectives for pentachlorobenzene. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

Table 16: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for Pentachlorobenzene.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	0.1
	Organism Only (µg/l)	0.1
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	-
	Organism Only (µg/l)	-
MCL	**(µg/l)**	-
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	**Organism only (µg/l)**	-
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

** "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.17. Selenium

Chemical Abstracts Service Registry Number: 7782-49-2

Synonyms: Se

General Information[43,44,45]: Selenium is a naturally occurring substance that is toxic at high concentrations, particularly when ingested, but is also a nutritionally essential element. It is usually encountered as an amorphous or crystalline, red to grey solid, which may become black upon exposure to ambient air. It is very common, but unevenly distributed in the earth's crust, usually found in rocks and soil. Selenium's elemental form is rarely found in the environment. Selenium is used in the electronics industry; the glass industry; in pigments used in plastics, paints, enamels, inks, and rubber; as a catalyst in the preparation of pharmaceuticals; in antidandruff shampoos (selenium sulfide); and as a constituent of fungicides. Selenium is also used as a nutritional feed additive for poultry and livestock, in pesticide formulations, and as an accelerator and vulcanizing agent in rubber production.

Selenium is insoluble in water and is not volatile. Selenium is corrosive, especially at high temperatures, and can emit toxic fumes when it decomposes under heat, but is not combustible. Selenium commonly enters the environment through weathering of rocks, volcanic eruptions, agricultural runoff, and burning coal and oil. Insoluble selenium compounds tend to be much less mobile than the water-soluble selenium compounds.

Food is the primary source of exposure to selenium. Humans are usually exposed to very low levels of selenium in air and water. Occasionally, higher levels of selenium may be found in drinking water, usually in areas where high levels of selenium in soil contribute to the selenium content of the water. Occupational exposure to selenium in the air may occur in the metal industries, selenium-recovery processes, painting, and special trades.

Acute (short-term) exposure to elemental selenium, hydrogen selenide, and selenium dioxide by inhalation results primarily in respiratory effects. Epidemiological studies of humans chronically (long-term) exposed to high levels of selenium in food and water have reported discoloration of the skin, deformation and loss of nails, loss of hair, tooth decay and discoloration, lack of mental alertness, and listlessness. Selenium causes irritation to the skin, eyes, and respiratory system. Epidemiological studies have reported an inverse association between selenium levels in the blood and cancer occurrence and animal studies have reported that selenium supplementation results in a reduced incidence of several tumor types. The only selenium compound that has been shown to be carcinogenic in animals is selenium sulfide, which resulted in an increase in liver tumors from oral exposure. The U.S. EPA has classified elemental selenium as a Group D, not classifiable as to human carcinogenicity, and selenium sulfide as a Group B2, probable human carcinogen. However, selenium and its related compounds are very toxic to aquatic organisms.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria as well as current applicable WQOs are shown in the Table below. The Basin Plan contains the Maximum Contaminant Level (MCL) for selenium specified in Table 64431-A of Section 64431 of Title 22 of the California Code of Regulations for the protection of MUN beneficial uses. In addition, the Basin Plan contains a narrative Toxicity WQO that applies to toxic substances in general. The Ocean Plan does not contain numeric water quality objectives for selenium. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

Table 17: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for Selenium.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	170
	Organism Only (µg/l)	4200
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	-
	Organism Only (µg/l)	-
MCL	**(µg/l)**	50
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	**Organism only (µg/l)**	-
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

** "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.18. Vinyl Chloride

Chemical Abstracts Service Registry Number: 75-01-4

Synonyms: chloroethene, chloroethylene, monochloroethene/ethylene, chlorethene/ethylene

General information[46,47]**:** Vinyl chloride is a manufactured chemical that does not exist naturally. It is a colorless gas at room temperature with a sweet, pleasant odor at higher concentrations in air, usually packaged and transported as a liquefied gas. The primary industrial purpose of this chemical is the creation of polyvinyl chloride (PVC). The chemical is slightly soluble in water. It is also extremely flammable, igniting easily with prolonged exposure to heat and potentially exploding depending on pressurization, releasing potentially toxic fumes when burned.

Vinyl chloride primarily enters the environment through air or wastewater releases from manufacturing or processing plants. While vinyl chloride does not occur naturally, it can appear in nature as the result of biodegradation of other manufactured chemicals, like trichloroethane. . Any leaks may involve either liquid or gas forms, though this chemical is expected to volatize from the liquid form quickly. Vinyl chloride volatizes easily and quickly from soil and water surfaces with reported half-lives from surface water and dry soil less than 48 hours. The gas reacts with hydroxyl radicals in the air and breaks down within a few days in the atmosphere into several other chemicals, including hydrochloric acid and formaldehyde.

As vinyl chloride preferentially exists as a gas at room temperatures, the primary route of exposure is inhalation. High concentrations of airborne vinyl chloride dust can occur quickly upon dispersion, increasing risk of explosion or inhalation. Inhaling high concentrations can cause respiratory irritation or damage or cause neurological damage resulting in dizziness, unconsciousness, convulsions, or seizures. Chronic exposure results in liver damage and increased risk of liver cancer. The vapor form is heavier than the ambient air and will tend to sink, causing risk of asphyxiation. Inhalation of high concentrations can cause dizziness, lung irritation, and unconsciousness. Exposure to the liquefied gas form may cause frostbite due to evaporative cooling as the chemical quickly evaporates. Vinyl chloride is a Group A1 chemical, meaning that it is a confirmed animal and human carcinogen and mutagen. In addition to being carcinogenic, vinyl chloride has adverse developmental and fertility effects. No evidence suggests that vinyl chloride bioaccumulates or biomagnifies to any significant degree. It is considered toxic to marine organisms and its degradants are also somewhat toxic.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria as well as current applicable WQOs are shown in the Table below. The Basin Plan contains the Maximum Contaminant Level (MCL) for vinyl chloride specified in Table 64444-A of Section 64444 of Title 22 of the California Code of Regulations for the protection of MUN beneficial uses. The CTR criteria for human health is also incorporated by reference in the Basin Plan. In addition, the Basin Plan contains a narrative Toxicity WQO that applies to toxic substances in general. The State Water Board Ocean Plan also includes a water quality objective for vinyl chloride applying to the consumption of fish collected in ocean waters.

Table 18: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for Vinyl Chloride.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	Water + Organism (µg/l)	0.022
	Organism Only (µg/l)	1.6
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	Water + Organism (µg/l)	2
	Organism Only (µg/l)	525
MCL	(µg/l)	0.5
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	Organism only (µg/l)	36
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

** "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.19. Zinc

Chemical Abstracts Service Registry Number: 7440-66-6

Synonyms: Zn

General information[48,49,50,51]**:** Zinc is ubiquitous in the environment and occurs in the earth's crust. The pure elemental form is a bluish-white, shiny metal. Its powdered form is explosive and may combust if stored in damp spaces. Zinc salts have numerous applications and are used in wood preservation, catalysts, corrosion control in drinking water systems, photographic paper, vulcanization acceleration for rubber, ceramics, textiles, fertilizers, pigments, batteries, and as nutritional supplements or medicines. Zinc chloride is a primary ingredient in smoke bombs used for crowd dispersal, in fire-fighting exercises, and by the military for screening purposes. Zinc chloride, zinc sulfate, zinc oxide, and zinc sulfide have dental, medical, and household applications. Zinc chloride and zinc sulfate are also used in herbicides.

The primary anthropogenic sources of zinc in the environment are from metal smelters and mining activities. The production and use of zinc in brass, bronze, die castings metal, alloys, rubbers, and paints may also lead to its release to the environment through various waste streams. Sludge and fertilizer increase zinc concentrations in soil. In addition, urban sources of zinc are ubiquitous and contribute significantly to the release of zinc in the environment. Those include outdoor zinc surfaces (especially galvanized metal) and tire wear debris. Once zinc binds to the surrounding soil, it tends to remain bound and does not dissolve in any water present in the soil as it is insoluble in water. Fine particles of zinc can become airborne, eventually settling, and can be removed from air by precipitation. Zinc released into surface water tends to sink to the bottom and bind to sediments but the amount that does dissolve increases the overall acidity of the water depending on how much dissolved zinc is present.

Zinc is an essential trace element that is crucial to survival and health maintenance, as well as growth, development, and maturation of developing organisms of all animal species. Thus, insufficient as well as excessive oral intake can cause toxicity and disease. Increased zinc consumption, as supplemental zinc, has been associated with decreased copper metalloenzyme activity which may induce copper deficiency, deficits in the number of red or white blood cells, decreases in cholesterol levels, immunotoxicity, and gastrointestinal effects. Inhalation exposure can result in metallic taste in the mouth accompanied by dryness and irritation of the throat and flu like symptoms. Inhalation exposure symptoms of zinc and its associated compounds primarily affects the respiratory system, potentially causing "metal fume fever." Zinc oxide is more corrosive and can cause more immediate damage to the body. Under the Guidelines for Carcinogen Risk Assessment (U.S. EPA, 2005), there is inadequate information to assess the carcinogenic potential of zinc. Excessive levels of zinc in aquatic environments are very toxic to aquatic life.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria are shown in the Table below. While the Basin Plan does not include specific human health objectives for zinc, it is addressed by the narrative toxicity objective that applies to toxic substances in general. In addition, although it is not part of Title 22 of the California Code of Regulations, the U.S. EPA provides a Primary MCL for zinc. The Ocean Plan also does not contain numeric water quality objectives for zinc. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: “The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health.”

Table 19: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for Zinc.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	7,400
	Organism Only (µg/l)	26,000
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	-
	Organism Only (µg/l)	-
MCL	**(µg/l)**	(5000)*
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	**Organism only (µg/l)**	-
Narrative Objective†		

*Not referenced in the Basin Plan

** “All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life….” Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region’s Basin Plan or statewide water quality control plans such as the California Ocean Plan.

† “The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health.”

3.20. 1,1,1-Trichloroethane

Chemical Abstracts Service Registry Number: 71-55-6

Synonyms: 1,1,1-TCA; Methyl chloroform

General information[52,53]: 1,1,1-Trichloroethane is a synthetic chemical that does not occur naturally in the environment. It is usually used in the liquid form where it is a colorless liquid with a sharp, sweet odor. It can be combustible under specific conditions, burning with difficulty but giving off potentially toxic fumes.

1,1,1-Trichloroethane was often used as a solvent to dissolve other substances, such as glues and paints. In industry, it was widely used to remove oil or grease from manufactured parts. In the home, it used to be an ingredient of products such as spot cleaners, glues, and aerosol sprays. No 1,1,1-trichloroethane is supposed to be manufactured for domestic use in the United States after January 1, 2002, because it affects the ozone layer. However, until 2005, limited amounts were still allowed to be produced for essential purposes.

Most of the 1,1,1-trichloroethane released into the environment enters the air. Spills, improper disposal, industrial emissions, and consumer use can release 1,1,1-trichloroethane into the environment. Contaminated water from landfills and hazardous waste sites can contaminate surrounding soil and nearby surface water or groundwater. It is slightly soluble in water, much more so in organic solvents, and its half-life in groundwater has been suggested to be between 200 – 300 days, but environmental conditions can greatly affect this estimation. However, this chemical volatizes quickly so most of the liquid chemical will likely evaporate eventually into the air. 1,1,1-Trichloroethane is expected to be in the vapor form when found in the environment. This chemical's degradants reduce the ozone layer as it undergoes photolysis in the stratosphere.

Studies in animals show that breathing air that contains very high levels of 1,1,1-trichloroethane (higher than 2,000 ppm) damages the breathing passages and causes mild effects in the liver, in addition to affecting the nervous system. There are no studies in humans that determine whether eating food or drinking water contaminated with 1,1,1-trichloroethane could harm health. Placing large amounts of 1,1,1-trichloroethane in the stomachs of animals has caused effects on the nervous system, mild liver damage, unconsciousness, and even death. Studies in animals suggest that repeated exposure of the skin might affect the liver and that very large amounts on the skin can cause death. These effects occurred only when evaporation was prevented. The most common exposure route for humans is inhalation but will mostly be exhaled other than a small amount absorbed by the body to be excreted later. Symptoms of high exposure to vapor 1,1,1-trichloroethane include narcotic effects like dizziness, drops in blood pressure, unconsciousness, and heart failure. Available information does not indicate that 1,1,1-trichloroethane causes cancer, meaning it is a Classification D, Group A4 chemical. This chemical is known to be harmful to aquatic organisms, but its bioconcentration potential is low.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria as well as current applicable WQOs are shown in the Table below. The Basin Plan contains the Maximum Contaminant Level (MCL) for 1,1,1 - Trichloroethane specified in Table 64444-A of Section 64444 of Title 22 of the California Code of Regulations for the protection of MUN beneficial uses. In addition, the Basin Plan contains a narrative Toxicity WQO that applies to toxic substances in general. The State Water Board Ocean Plan includes a water quality objective for 1,1,1-trichloroethane applying to the consumption of fish collected in ocean waters.

Table 20: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for 1,1,1-trichloroethane.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	10,000
	Organism Only (µg/l)	200,000
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	-
	Organism Only (µg/l)	-
MCL	**(µg/l)**	200
Narrative Toxicity Objective*		

California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	Organism only (µg/l)	540,000
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

** "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.21. 1,2,4,5-Tetrachlorobenzene

Chemical Abstracts Service Registry Number: 95-94-3

Synonyms: none

General information[54,55,56,57,59]: 1,2,4,5-Tetrachlorobenzene is man-made substance, usually encountered as solid ranging from colorless crystal to white flaky or chunky solid with a strong unpleasant odor. It is used as an intermediate or building block to make herbicides, insecticides and defoliants. It is also used to make other chemicals like 2,4,5- trichlorophenol and 2,4,5-trichlorophenoxyacetic acid. This chemical is both combustible and explosive when exposed to flames or strong oxidizers, releasing potentially toxic fumes when burned.

1,2,4,5-tetrachlorobenzene can enter the environment through pesticide waste streams or as the degradant of petachlorobenzene or hexachlorobenzene. It is insoluble in water but is expected to volatize from water surfaces and wet soil, attenuated by its strong tendency to bind to surrounding particles. This chemical is expected to exist in the vapor form when exposed to the ambient atmosphere with a half-life of roughly 200 days as it is degraded by hydroxyl radicals. Its half-life in model water and soil conditions is just over a month. It is not readily biodegradable.

1,2,4,5-Tetrachlorobenzene exposure can occur due to inhalation, ingestion of contaminated drinking water, or dermal absorption. This chemical irritates the eyes and skin and detrimentally affects mucous membranes, affecting among other things the ability to breath. The substance may have effects on the liver and the kidneys, potentially impairing the liver. Laboratory animals exposed to 1,2,4,5- tetrachlorobenzene experienced lesions, or changes to the liver and kidney.

This substance has not undergone a complete evaluation and determination under U.S. EPA's IRIS program for evidence of human carcinogenic potential. Dermal or eye exposure will result in irritation and inhalation can cause irritation to the nose and throat. High exposure levels can cause muscle weakness, fatigue, lowered body temperature, coma, and death. Long-term exposure can be hazardous to the liver and kidneys. The substance is very toxic to aquatic organisms and bioaccumulation of this chemical may occur in fish.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria are shown in the Table below. While the Basin Plan does not include specific human health objectives for 1,2,4,5-Tetrachlorobenzene, it is addressed by the narrative toxicity objective that applies to toxic substances in general. The Ocean Plan also does not contain numeric water quality objectives for 1,2,4,5-Tetrachlorobenzene. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

Table 21: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for 1,2,4,5-Tetrachlorobenzene.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	0.03
	Organism Only (µg/l)	0.03
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	-
	Organism Only (µg/l)	-
MCL	**(µg/l)**	-
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	**Organism only (µg/l)**	-
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

** "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.22. 1,2,4-Trichlorobenzene

Chemical Abstracts Service Registry Number: 120-82-1

Synonyms: unsymmetrical-Trichlorobenzene; unsymmetrical-TCB

General Information[59,60,61,62,63]: Aside from its use as a solvent in chemical manufacturing, this compound is a useful precursor to dye and pesticides, acting as a dye carrier or a herbicide intermediate. Other uses include acting as a heat-transfer medium, a degreaser, and a lubricant. It is used in the liquid form, which is clear with an aromatic odor, but can also exist as a crystalline solid below 65 degrees Fahrenheit.

When released into the atmosphere, 1,2,4-trichlorobenzene will tend to convert completely to the vapor form. Vapor 1,2,4-trichlorobenzene has a half-life of about a month in the atmosphere, degraded by hydroxyl radicals. Fairly high vapor pressure and Henry's Law constant values indicate that this chemical will readily volatize from the surface of water or soil, particularly moist soils. It is not particularly mobile in soils and tends to adsorb to the surrounding soil, which can attenuate the volatilization. It is only slightly degraded by photolysis or hydrolysis but is biodegraded in soils with a half-life ranging from about a month to over 100 days depending whether the environment is aerobic or anaerobic. In water, it tends to bind to suspended particles, slowing down the volatilization from water surfaces.

1,2,4-Trichlorobenze exposure for humans is primarily due to inhalation or to consumption of contaminated water and food. High concentrations will cause irritation to the respiratory system, with risks to the kidneys and liver increasing with length and frequencies of exposures. The kidneys and liver can also be damaged through ingestion. Eye or skin exposure will cause moderate irritation and some pain. This chemical is also combustible and emits potentially toxic fumes when burned. 1,2,4-Trichlorobenze has not been established to cause cancer in humans and is considered as being in the Group D Cancer Classification. Animal testing on mice and rats also found no significant evidence of carcinogenicity. Studies on aquatic organisms found 1,2,4-triclhlorobenzene as having high capacity to bioaccumulate in organisms. It is moderately to highly toxic to aquatic organisms, mortality occurring across all studied organism groups except for aquatic plants and phytoplankton, which both showed detrimental population -level effects.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria as well as current applicable WQOs are shown in the Table below. The Basin Plan contains the Maximum Contaminant Level (MCL) for 1,2,4–Trichlorobenzene specified in Table 64444-A of Section 64444 of Title 22 of the California Code of Regulations for the protection of MUN beneficial uses. In addition, the Basin Plan contains a narrative Toxicity WQO that applies to toxic substances in general. The Ocean Plan does not contain numeric water quality objectives for this chemical. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

Table 22: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for 1,2,4–Trichlorobenzene.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	0.071
	Organism Only (µg/l)	0.076
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	-
	Organism Only (µg/l)	-
MCL	**(µg/l)**	5
Narrative Toxicity Objective*		

California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	Organism only (µg/l)	-
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

** "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.23. 1,3 – Dichloropropene

Chemical Abstracts Service Registry Number: 542-75-6

Synonyms: 1,3-Dichloropropylene; component of D-D; Telone II, 1,3-D

General Information[64,65,66]: 1,3-dichloropropene is among the most extensively used fumigants in California, mostly used to control pests in the soil, such as nematodes, bacteria, and even viruses. It is stored as a liquid ranging from colorless to straw-colored or amber with a sweetish, chloroform-like odor. When used, 1,3-D is formulated for soil fumigation through shank application or formulated as an emulsifiable concentrate for drip application. It is flammable with a flash point of 77 degrees Celsius and is a dangerous fire hazard when exposed to flames or oxidizers, emitting toxic fumes when heated to decomposition.

1,3-dichloropropene is soluble in water at room temperature and has a high rate of hydrolysis, breaking down in the presence of water. However, when released into the environment, 1,3-D volatizes easily from soil and exists mostly as a vapor. It strongly binds to soil, especially when in the vapor phase, and has long persistence times in soil, up to a half-life of 69 days. Due to its tendency to strongly adsorb to soils, there is little risk of 1,3-D leaching through soil. Despite this, 1,3-D is surprisingly mobile in soils due to diffusion of the vapor-phase, with lower mobility in water-saturated or high organic matter-containing soils. Due to the strong adsorption to soil and high rate of hydrolysis when exposed to water, runoff is not a significant issue for spreading 1,3-D.

1,3-dichloropropene occupational exposure risk, particularly for agricultural workers, is higher than the general public, which can generally only be exposed to lower concentrations in ambient air or drinking water in areas of 1,3-D use. 1,3-D is toxic if ingested but potentially fatal if aspirated. It is highly corrosive and can cause potentially serious skin and eye irritation. It may also cause harmful irritation to the respiratory system if inhaled. Inhalation of high concentrations of 1,3-D can cause coughing, substernal pain, extreme respiratory distress, and central nervous system depression. 1,3-D is classified as a Group A3 chemical, meaning that it is a known animal carcinogen though its carcinogenicity for humans is not well established. 1,3,-D is moderately to very highly toxic to aquatic life depending on species. It can have long-term detrimental effects to an aquatic environment though its potential to bioaccumulate in organic tissues is low.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria as well as current applicable WQOs are shown in the Table below. The Basin Plan contains the Maximum Contaminant Level (MCL) for 1,3 Dichloropropene specified in Table 64444-A of Section 64444 of Title 22 of the California Code of Regulations for the protection of MUN beneficial uses. The CTR criteria for human health is also incorporated by reference in the Basin Plan. In addition, the Basin Plan contains a narrative Toxicity WQO that applies to toxic substances in general. The State Water Board Ocean Plan also includes a water quality objective for 1,3 Dichloropropene applying to the consumption of fish collected in ocean waters.

Table 23: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for Dichloropropene.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	0.27
	Organism Only (µg/l)	12
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	10
	Organism Only (µg/l)	1700
MCL	**(µg/l)**	0.5
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	**Organism only (µg/l)**	8.9
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

** "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.24. 2,4,5-Trichlorophenol

Chemical Abstracts Service Registry Number: 95-95-4

Synonyms: none

General Information[67,68,69,70,71]: 2,4,5-Trichlorophenol is used as a fungicide in paper and pulp mills, as an herbicide, and as an intermediate in the manufacture of other pesticides. It is a solid at room temperature, ranging from colorless needles to gray flakes to off-white and lumpy. 2,4,5-trichlorophenol is a weak acid, though it is insoluble in water. It tends to have a sickeningly sweet and tarry (phenolic) odor. It is also combustible, though not explosive, under specific conditions when in contact with open flames or strong oxidants, giving off potentially toxic fumes.

2,4,5-Trichlorophenol often enters the environment from industrial and agricultural sources. The effects found in aquatic organisms ranged from inhibited growth to mortality, and it bioaccumulates in organisms. Overall, it is very toxic to virtually all types of aquatic organisms and has the potential to cause long-term detrimental effects in an aquatic environment due to its insolubility in water giving the chemical longer persistence times in water. Its effects on terrestrial organisms other than humans has not been well researched but the chemical is definitely a threat to freshwater and marine life.

Humans can be exposed through inhalation, ingestion, and dermal contact, especially during production or pesticide-application of this chemical. 2,4,5-trchlorophenol causes burning irritation to the skin and eyes and irritates the respiratory tract to cause sore throat and coughing. Ingestion results in abdominal pain and diarrhea as well as dizziness, headaches, and vomiting. Other toxic effects include depressed activity levels, motor weakness, convulsive seizures, fever, and decreased respiratory rate, though these are more likely to occur with chronic exposure. Chronic effects of this chemical are not well studied. This chemical can potentially cause lung, kidney, and liver damage. There is limited evidence in humans for the carcinogenicity of combined exposures to polychlorophenols or to their sodium salts. There is inadequate evidence in experimental animals for the carcinogenicity of 2,4,5-trichlorophenol (Group D). Overall, combined exposures to polychlorophenols such as 2,4,5-trichlorophenol or to their sodium salts are possibly carcinogenic to humans (Group 2B). Long term effects are not well studied but it does not seem to be a reproductive hazard at chronic levels. 2,4,5-trichlorophenol is very toxic to aquatic organisms with a potentially very high capacity for bioaccumulation in organisms.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria are shown in the Table below. While the Basin Plan does not include specific human health objectives for 2,4,5-Trichlorophenol, it is addressed by the narrative toxicity objective that applies to toxic substances in general. The Ocean Plan also does not contain numeric water quality objectives for 2,4,5-Trichlorophenol. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: “The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health.”

Table 24: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for 2,4,5-Trichlorophenol.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	300
	Organism Only (µ/l)	600
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	-
	Organism Only (µg/l)	-
MCL	**(µg/l)**	-
Narrative Toxicity Objective*		

California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	Organism only (µg/l)	-
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

** "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.25. 3-Methyl-4-Chlorophenol

Chemical Abstracts Service Registry Number: 59-50-7

Synonyms: chlorocresol; 4-Chloro-3-methylphenol; p-Chloro-m-cresol; 4-Chloro-m-cresol

General Information[72,73,74]: 3-methyl-4-chlorophenol is a germicide, microbiocide, and fungicide used as a topical antiseptic and as a preservative for various products, such as glues, gums, paints, inks, textile, leather goods and cosmetics. It is a crystalline solid, ranging from white to light pink, with a sickeningly sweet and tarry (phenolic) odor. Pure 3-methyl-4-chlorophenol is effectively odorless, however. While it has a high flash point, this chemical should be kept away from open flames as it produces toxic and corrosive fumes when burned. 3-methyl-4-chlorophenol is hygroscopic (absorbs moisture from air) and is soluble in an aqueous base, but it incompatible with bases, acid chlorides/anhydrides, and oxidizers

Environmental release of 3-methyl-4-chlorophenol may occur through inadvertent formation in waters (potable water, wastewater, cooling water) that have undergone chlorination treatment as well as by evaporation or waste releases from product formulation or end-products containing 3-methyl-4-chlorophenol. 3-methyl-4-chlorophenol is not water soluble, dissolving in alkalies, organic solvents, fats, and oils, and is not expected to volatize into a vapor form as it has very low vapor pressure and Henry's Law constant values. If it is released into the environment in the vapor stage, 3-methyl-4-chlorophenol will remain gaseous and degrade quickly due to photochemically-created hydroxyl radicals. It is readily biodegradable in aerobic environments but does not degrade in anaerobic environments, leading to potentially longer persistence times in low-oxygenated waters. Leaching through soil is expected for this chemical, though it will slowly biodegrade as it travels through the aerobic soil.

The general population can be exposed to 3-methyl-4-chlorophenol through dermal contact with products containing this chemical or through ingestion of chlorinated drinking water where the chemical formed as a byproduct of chlorination. This chemical is a skin and eye irritant that can be absorbed through the skin, inhalation, or ingestion. Dermal contact causes irritation and potential serious chemical burns and causes increased skin sensitivity with chronic exposure. Inhalation can cause a cough and sore throat with potential headache, dizziness, and shortness of breath. Ingestion systems are similar with less respiratory symptoms and the addition of abdominal pain, vomiting, and diarrhea. 3-methyl-4-chlorophenol is not classified as a human carcinogen (Group D). This chemical is very toxic to aquatic life with long-lasting effects. While effects on wildlife have not been well studied, bioaccumulation seems unlikely to occur in species other than fish. High concentrations ingested by lab animals show some risk of kidney damage and potential skin necrosis but exposure to such concentrations is unlikely.

Water Quality Objectives: The updated U.S. EPA Human Health Water Quality Criteria are shown in the Table below. While the Basin Plan does not include specific human health objectives for 3-Methyl-4-Chlorophenol, it is addressed by the narrative toxicity objective that applies to toxic substances in general. The Ocean Plan also does not contain numeric water quality objectives for 3-Methyl-4-Chlorophenol. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

Table 25: Updated U.S. EPA Human Health Water Quality Criteria and current applicable WQOs for 3-Methyl-4-Chlorophenol.

Updated EPA Human Health Water Quality Criteria		
EPA Human Health Criteria for the Consumption of	**Water + Organism (µg/l)**	500
	Organism Only (µg/l)	2,000
Los Angeles Water Board Basin Plan		
CTR Human Health criteria	**Water + Organism (µg/l)**	-
	Organism Only (µg/l)	-
MCL	**(µg/l)**	-
Narrative Toxicity Objective*		
California Ocean Plan		
Numerical Water Quality Objective for Human Health Protection	**Organism only (µg/l)**	-
Narrative Objective**		

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.
** "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

3.26. Human Health Section 304(a) Water Quality Criteria Recommendations for Pollutants Included in the CTR

As mentioned before, pollutants with criteria established in the CTR may require further action by the U.S. EPA to de-promulgate the existing criteria before updated objectives could be used in regulatory actions. Detailed descriptions of these pollutants are not included in the present appendix; however, more details about these chemicals are provided on U.S. EPA's website[m,n]. The list of section 304(a) human health water quality criteria recommendations published by the U.S. EPA since May 30, 2000 that are part of the CTR is provided in the table below, along with WQOs currently applicable. Note that pollutants for which the CTR criteria are higher than the MCL were addressed in the previous sections, since in certain circumstances the more stringent MCLs would need to be applied to determine effluent limits rather than the CTR criteria.

[m] https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table

[n] https://www.epa.gov/wqs-tech/water-quality-standards-establishment-numeric-criteria-priority-toxic-pollutants-state

Table 26: Section 304(a) human health water quality criteria recommendations published by the U.S. EPA since May 30, 2000 that are part of CTR and current applicable WQOs. Rows that are italicized indicate that the U.S. EPA recommended criteria are less stringent than the existing CTR criteria.

Chemical	CAS No.	Updated EPA Water Quality Criteria		Los Angeles Water Board Basin Plan					California Ocean Plan	
		Human Health Criteria		CTR Human Health		MCL†	Regional Objective	Toxicity Objective ‡	Water Quality Objective	Narrative Objective ±
		Water + Organism (µg/l)	Organism Only (µg/l)	Water + Organism (µg/l)	Organism Only (µg/l)	(µg/l)	(pg/L) 30-d average		Organism only (µg/l)	
Acenaphthene	83-32-9	70	90	1,200	2,700					
Acrolein	107-02-8	3	400	320	780				220	
Acrylonitrile	*107-13-1*	*0.061*	*7*	*0.059*	*0.66*				*0.1*	
Aldrin	309-00-2	7.7E-07	7.7E-07	0.00013	0.00014				2.2E-05	
alpha-Hexachlorocyclohexane (HCH)	319-84-6	0.00036	0.00039	0.0039	0.013					
alpha-Endosulfan	959-98-8	20	30	110	240					
Anthracene	120-12-7	300	400	9,600	110,000					
Antimony*	7440360	5.6	640	14	4300	6			1,200	
Benzene*	71-43-2	0.58 - 2.1	16 - 58	1.2	71	1			5.9	
Benzidine	*92-87-5*	*0.00014*	*0.011*	*0.00012*	*0.00054*				*6.9E-05*	
Benzo(a)anthracene	56-55-3	0.0012	0.0013	0.0044	0.049					
Benzo(a)pyrene	50-32-8	0.00012	0.00013	0.0044	0.049					
Benzo(b)fluoranthene	205-99-2	0.0012	0.0013	0.0044	0.049					
Benzo(k)fluoranthene	207-08-9	0.012	0.013	0.0044	0.049					
beta-Hexachlorocyclohexane (HCH)	319-85-7	0.008	0.014	0.014	0.046					
beta-Endosulfan	33213-65-9	20	40	110	240					
Bis(2-Chloro-1-Methylethyl) Ether	108-60-1	200	4,000	1,400	170,000					
Bis(2-Chloroethyl) Ether	*111-44-4*	*0.03*	*2.2*	*0.031*	*1.4*				*0.045*	
Bis(2-Ethylhexyl) Phthalate	117-81-7	0.32	0.37	1.8	5.9	4			3.5	
Bromoform	75-25-2	7	120	4.3	360					
Butylbenzyl Phthalate	85-68-7	0.1	0.1	3,000	5,200					

Chemical	CAS No.	Updated EPA Water Quality Criteria		Los Angeles Water Board Basin Plan					California Ocean Plan	
		Human Health Criteria		CTR Human Health		MCL†	Regional Objective	Toxicity Objective ‡	Water Quality Objective	Narrative Objective ±
		Water + Organism (µg/l)	Organism Only (µg/l)	Water + Organism (µg/l)	Organism Only (µg/l)	(µg/l)	(pg/L) 30-d average		Organism only (µg/l)	
Carbon Tetrachloride	*56-23-5*	*0.4*	*5*	*0.25*	*4.4*	*0.5*			*0.9*	
Chlordane	57-74-9	0.00031	0.00032	0.00057	0.00059	0.1			2.3E-05	
Chlorobenzene	108-90-7	100	800	680	21,000	70			570	
Chlorodibromomethane	124-48-1	0.8	21	0.401	34	(80)			8.6	
Chrysene	*218-01-9*	*0.12*	*0.13*	*0.0044*	*0.049*					
Cyanide*	57-12-5	4	400	700	220000	(150)				
Dibenzo(a,h)anthracene	53-70-3	0.00012	0.00013	0.0044	0.049					
Dichlorobromomethane	75-27-4	0.95	27	0.56	46	(80)			6.2	
Dieldrin	60-57-1	1.2E-06	1.2E-06	0.00014	0.00014				4.0E-05	
Diethyl Phthalate	84-66-2	600	600	23,000	120,000				33,000	
Dimethyl Phthalate	131-11-3	2,000	2,000	313,000	2,900,000				820,000	
Di-n-Butyl Phthalate	84-74-2	20	30	2,700	12,000				3,500	
Endosulfan Sulfate	1031-07-8	20	40	110	240					
Endrin	72-20-8	0.03	0.03	0.76	0.81	2				
Endrin Aldehyde	*7421-93-4*	*1*	*1*	*0.76*	*0.81*					
Ethylbenzene	100-41-4	68	130	3100	29,000	300			4,100	
Fluoranthene	206-44-0	20	20	300	370				15	
Fluorene	86-73-7	50	70	1,300	14,000					
gamma-Hexachlorocyclohexane (HCH) (Lindane)	*58-89-9*	*4.2*	*4.4*	*0.019*	*0.063*	*(0.2)*				
Heptachlor	76-44-8	5.9E-06	5.9E-06	0.00021	0.00021	0.01			5.0E-05	
Heptachlor Epoxide	1024-57-3	3.2E-05	3.2E-05	0.0001	0.00011	0.01			2.0E-05	
Hexachlorobenzene	118-74-1	7.9E-05	7.9E-05	0.00075	0.00077	1			0.00021	
Hexachlorobutadiene	87-68-3	0.01	0.01	0.44	50				14	

Chemical	CAS No.	*Updated EPA Water Quality Criteria*		*Los Angeles Water Board Basin Plan*					*California Ocean Plan*	
		Human Health Criteria		CTR Human Health		MCL†	Regional Objective	Toxicity Objective ‡	Water Quality Objective	Narrative Objective ±
		Water + Organism (µg/l)	Organism Only (µg/l)	Water + Organism (µg/l)	Organism Only (µg/l)	(µg/l)	(pg/L) 30-d average		Organism only (µg/l)	
Hexachlorocyclopentadiene	77-47-4	4	4	240	17,000	50			58	
Hexachloroethane	67-72-1	0.1	0.1	1.9	8.9				2.5	
Indeno(1,2,3-c,d)pyrene	193-39-5	0.0012	0.0013	0.0044	0.049					
Isophorone	*78-59-1*	*34*	*1,800*	*8.4*	*600*				*730*	
Methyl Bromide	*74-83-9*	*100*	*10,000*	*48*	*4,000*					
Methylene Chloride	75-09-2	20	1,000	4.7	1600	(5)				
Nitrobenzene	98-95-3	10	600	17	1900				4.9	
Nitrosodibutylamine, N	924-16-3	0.0063	0.22	0.00069	8.1					
N-Nitrosodimethylamine (NDMA)	62-75-9	0.00069	3.00	0.00069	8.1				7.3	
N-Nitrosodi-n-Propylamine	621-64-7	0.005	0.51	0.005	1.4				0.38	
N-Nitrosodiphenylamine	86-30-6	3.3	6.0	5	16				2.5	
Pentachlorophenol	87-86-5	0.03	0.04	0.28	8.2	1				
Phenol	108-95-2	4,000	300,000	21,000	4,600,000					
PCBs	1336-36-3	6.4E-05	6.4E-05	0.00017	0.00017	0.5	70		1.9E-05	
Pyrene	129-00-0	20	30	960	11,000					
Tetrachloroethylene (Perchloroethylene)	*127-18-4*	*10*	*29*	*0.8*	*8.85*	*5*			*2.0*	
Thallium	7440280	0.24	0.47	1.7	6.3	2			2.0	
Toluene	108-88-3	57	520	6,800	200,000	150			85,000	
Toxaphene	8001-35-2	0.0007	0.00071	0.00073	0.00075	3			0.00021	
Trichloroethylene (TCE)	79-01-6	0.6	7	2.7	81	5			27	
Vinyl Chloride*	75-01-4	0.022	1.6	2	525	0.5			36	
1,1,2,2-Tetrachloroethane	79-34-5	0.2	3	0.17	11	1			2.3	
1,1,2-Trichloroethane	*79-00-5*	*0.55*	*8.9*	*0.6*	*42*	*5*			*9.4*	

Chemical	CAS No.	***Updated EPA Water Quality Criteria***		***Los Angeles Water Board Basin Plan***					***California Ocean Plan***	
		Human Health Criteria		**CTR Human Health**		**MCL†**	**Regional Objective**	**Toxicity Objective ‡**	**Water Quality Objective**	**Narrative Objective ±**
		Water + Organism (µg/l)	**Organism Only (µg/l)**	**Water + Organism (µg/l)**	**Organism Only (µg/l)**	**(µg/l)**	**(pg/L) 30-d average**		**Organism only (µg/l)**	
1,1-Dichloroethylene	*75-35-4*	*300*	*20,000*	*0.057*	*3.2*	*6*			*0.9*	
1,2-Dichlorobenzene	95-50-1	1,000	3,000	2700	17,000	600				
1,2-Dichloroethane	107-06-2	9.9	650	0.38	99	0.5			28	
1,2-Dichloropropane	78-87-5	0.9	31	0.52	39	5				
1,2-Diphenylhydrazine	122-66-7	0.03	0.2	0.04	0.54				0.16	
trans-1,2-Dichloroethylene (DCE)	156-60-5	100	4,000	700	140,000	10				
1,3-Dichlorobenzene	541-73-1	7	10	400	2600					
1,3-Dichloropropene*	542-75-6	0.27	12	10	1700	0.5			8.9	
1,4-Dichlorobenzene	106-46-7	300	900	400	2600	5			18	
2,3,7,8-TCDD (Dioxin)	1746-01-6	5.00E-09	5.10E-09	1.30E-08	1.40E-08	3.00E-08				
2,4,6-Trichlorophenol	88-06-2	1.5	2.8	2.1	6.5				0.29	
2,4-Dichlorophenol	120-83-2	10	60	93	790					
2,4-Dimethylphenol	105-67-9	100	3,000	540	2300					
2,4-Dinitrophenol	51-28-5	10	300	70	14,000				4.0	
2,4-Dinitrotoluene	121-14-2	0.049	1.7	0.11	9.1				2.6	
2-Chloronaphthalene	91-58-7	800	1,000	1,700	4,300					
2-Chlorophenol	95-57-8	30	800	120	400					
2-Methyl-4,6-Dinitrophenol	534-52-1	2	30	13.4	765					
3,3'-Dichlorobenzidine	91-94-1	0.049	0.15	0.04	0.077				0.0081	
p,p'-Dichlorodiphenyldichloroethane (DDD)	72-54-8	0.00012	0.00012	0.00083	0.00084					
p,p'-Dichlorodiphenyldichloroethylene (DDE)	72-55-9	1.8E-05	1.8E-05	0.00059	0.00059					
p,p'-Dichlorodiphenyltrichloroethane (DDT)	50-29-3	0.00003	0.00003	0.00059	0.00059				0.00017	

* Chemicals for which the MCL objective is lower than the CTR number. Those were addressed separately in the previous sections.

† Numbers in parenthesis represent MCLs provided by the U.S. EPA, but not part of Title 22 of the California Code of Regulations and therefore not included in the Basin Plan.

‡ "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

± "The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health."

4. Section 304(a) Water Quality Criteria Recommendations for the Protection of Aquatic Life

4.1. Acrolein

Chemical Abstracts Service Registry Number: 107-02-8

Synonyms: Acrylaldehyde, 2-propenal, propenal, acrylic aldehyde

General Information[75,76,77]: Acrolein is a clear or yellow liquid with a burnt, sweet pungent odor, also described as disagreeable, detectable at 0.25 parts per million (ppm). Acrolein is a pesticide used primarily in manufacturing other chemicals as well as in controlling underwater plant, algae, and slime growth in industrial irrigation canals and water supplies. Acrolein can be found in some livestock feeds and is used to produce chemical weapons, though only in much greater concentrations. It is volatile, flammable, and explosive, especially when in contact with bases, acids, or strong oxidizers.

Acrolein can be formed and volatized in small amounts as a result of burning, particularly for organic matter, oil, and gasoline, but can be fatal when formed from building fires. It can also enter the environment from accidental release from chemical plants or hazardous waste sites. Acrolein is very soluble in water or organic solvents. It volatizes very easily from both water and soils, evaporating faster than water especially at higher temperatures. Acrolein does not remain in the environment for long, changing into other chemicals in air and water within days or even hours. It can adsorb to soil or particulate substances.

Acrolein is extremely toxic with a probable human lethal ingestion dosage of at most 1 teaspoon for an average-sized person. Inhalation of 10 ppm concentration of acrolein in air will cause death within minutes. At sub-lethal levels, acrolein is severely irritating to eyes, skin, upper respiratory tract, and any contacted mucous membranes. Occupational exposure risk through inhalation or dermal contact is higher than the risk to the general population but is likely underestimated due to confidential business information or unknown variables. The general population is likely to be exposed to acrolein via inhalation of ambient air, ingestion of contaminated food, or smoking cigarettes, e-cigarettes, and cannabis. Inhalation of second-hand smoke and exhaust fumes (petrochemical fuel combustion) are also significant vectors of exposure for the general population.

Animals that ingested acrolein in experimental testing exhibited vomiting as well as stomach irritation, ulcers, and bleeding. Terrestrial plants and invertebrates tolerate high acrolein exposure, with only some plants showing adverse effects when exposed to 500 µg acrolein/L air. Acrolein reduces survival in birds, particularly when ingested. Acrolein is a cytotoxic and cilostatic agent in mammals that irritates mucous membranes in the digestive and respiratory tracts, as well as skin and eyes, and is systemically toxic by all routes of exposure. Acrolein is not currently considered a human carcinogen as existing data is inadequate to draw a comprehensive conclusion. Acrolein is lethal to most sensitive aquatic organisms, with vertebrates being more sensitive than invertebrates and with sensitivity decreasing with age. Overall, acrolein is very toxic to aquatic organisms but has low potential for bioaccumulation.

Water Quality Objectives: The updated U.S. EPA Aquatic Life Water Quality Criteria are shown in the Table below. While the Basin Plan does not include specific aquatic life objectives for Acrolein, it is addressed by the narrative toxicity objective that applies to toxic substances in general. The Ocean Plan also does not contain numeric water quality objectives for Acrolein for the protection of aquatic life. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: "Marine communities, including vertebrate, invertebrate, algae, and plant species, shall not be degraded." Additionally, Table 1 of the Ocean Plan includes numeric toxicity objectives, which aid in addressing pollutants that may not have specific numeric objectives.

Table 27: Updated U.S. EPA Aquatic Life Water Quality Criteria and current applicable WQOs for Acrolein.

Updated EPA Water Quality Criteria			
EPA Aquatic Life Criteria	**Freshwater**	**CMC (acute) (µg/L)**	3
		CCC (chronic) (µg/L)	3
	Saltwater	**CMC (acute) (µg/L)**	-
		CCC (chronic) (µg/L)	-
Los Angeles Water Board Basin Plan			
CTR Aquatic Life criteria	**Freshwater**	**CMC (acute) (µg/L)**	-
		CCC (chronic) (µg/L)	-
	Saltwater	**CMC (acute) (µg/L)**	-
		CCC (chronic) (µg/L)	-
Narrative Toxicity Objective*			
California Ocean Plan			
Numerical Water Quality Objective for Protection of Marine Aquatic Life	**Saltwater**	**6-Month Median (µg/L)**	-
		Daily Maximum (µg/L)	-
		Instantaneous Maximum (µg/L)	-
Narrative Objective**			

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.
** "Marine communities, including vertebrate, invertebrate, algae, and plant species, shall not be degraded."

4.2. Ammonia

Chemical Abstracts Service Registry Number: 7664-41-7

Synonyms: ammonia gas, azane, Spirit of hartshorn, Nitro-sil

General Information[78,79]: Ammonia is a naturally forming chemical that is also manufactured by humans in roughly equal amounts. Ammonia is a colorless gas with a sharp odor that can be compressed into a liquid under pressure. Ammonia is very water-soluble and changes into ammonium ions in water, which are not gaseous and without odor. The ammonium ion form is the form usually naturally found in wells, rivers, lakes, and wet soils. Ammonia is a vital source of nitrogen for plants and animals, primarily generated in nature by decomposition of organic matter. Ammonia is primarily used as fertilizer but is also involved in the manufacturing of many cleaning products, synthetic fibers, plastics, and explosives.

Ammonia exists naturally in low concentrations in air, soil, and water. Ammonia is naturally recycled by organisms for usable nitrogen so it does not last more than roughly a week in air, water, and soil. However, high concentrations can overwhelm the natural recycling process and increase the time ammonia is present in the environment based only on its chemical properties. Anthropogenic ammonia gas most often enters the environment from fertilizers, air releases from manufacturing or processing facilities, decaying livestock, and sewage. Ammonia in water primarily enters the environment from effluent releases by wastewater treatment facilities and runoff from agriculture. Ammonia easily volatizes but can be removed from air by precipitation washout or even the water present in clouds. Ammonia will volatize faster from surface water with increasing pH and temperature. Adsorption to sediments and suspended organic matter increases with greater organic content and metal ion count as well as decreased pH.

Exposure routes for the general population are inhalation of ambient air with ammonia or contact with consumer products that use ammonia (e.g. household cleaners). People living in agricultural areas or highly concentrated animal populations (e.g. factory farms), may also be exposed to ammonia. Ammonia is not considered a carcinogen and is actually beneficial to organisms at low levels. Ammonia is irritating and corrosive at excessive exposure levels. Exposures to high concentrations of ammonia gas can cause chemical burns to the skin, eyes, and respiratory system and can dissolve in the water present in mucous membranes to create the necrotizing base ammonium hydroxide. Inhalation can cause potentially lethal airway blockage and respiratory insufficiency. Exposures to liquid ammonia can cause cryogenic injury and alkali burns. Ingestion of this corrosive chemical can cause severe chemical burns and hemorrhaging in the digestive system. Ammonia in high concentrations is very toxic to aquatic life with long-lasting effects.

Water Quality Objectives: The updated U.S. EPA Aquatic Life Water Quality Criteria as well as current applicable WQOs are shown in the Table below.

The 2013 U.S. EPA recommended water quality criteria for the protection of aquatic life from the toxic effects of ammonia in freshwater (EPA 822-R-13-001) take into account data for several sensitive freshwater mussel species in the Family Unionidae that had not previously been tested. As a result, the 2013 acute criterion magnitude is determined primarily by effects on freshwater unionid mussels for water temperatures greater than 15.7°C (at lower temperatures, the magnitude is based primarily on effects on salmonids and other fish), and the chronic criterion magnitude is determined primarily by the effects on freshwater mollusks, particularly unionid mussels throughout the temperature range.

In order to address the applicability of these criteria to the Los Angeles Region, the presence of unionid mussels in the region's freshwater bodies first needs to be determined. As a first step towards the reconsideration of the freshwater ammonia criteria, in 2016 the Regional Water Board entered into contract with the University of California Santa Barbara to determine whether native unionidae mussels, which have been historically found from the Los Angeles and Ventura County coastal drainages, are currently present.

Table 28: Updated U.S. EPA Aquatic Life Water Quality Criteria and current applicable WQOs for Ammonia.

Updated EPA Water Quality Criteria			
EPA Aquatic Life Criteria	**Freshwater**	**CMC (acute) (µg/L)**	pH, T and species dependent
		CCC (chronic) (µg/L)	
	Saltwater	**CMC (acute) (µg/L)**	
		CCC (chronic) (µg/L)	
Los Angeles Water Board Basin Plan			
CTR Aquatic Life criteria	**Freshwater**	**CMC (acute) (µg/L)**	-
		CCC (chronic) (µg/L)	-
	Saltwater	**CMC (acute) (µg/L)**	-
		CCC (chronic) (µg/L)	-
Regional Objective for Inland Surface Waters	**Freshwater***	**1-hour average (µg/L)**	pH, T and early-life stages of fish dependent
		4-days average (µg/L)	2.5 times the 30-day average objective
		30-days average (µg/L)	pH and fish species dependent
	Saltwater / Brackish water	**1-hour average (µg/L)**	233
		4-days average (µg/L)	35
Narrative Toxicity Objective**			
California Ocean Plan			
Numerical Water Quality Objective for Protection of Marine Aquatic Life	**Saltwater**	**6-Month Median (µg/L)**	600
		Daily Maximum (µg/L)	2,400
		Instantaneous Maximum (µg/L)	6,000
Narrative Objective†			

*For some of the Region's freshwater streams, the Basin Plan ammonia objectives are expressed as Site Specific Objectives (SSOs).

** “All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life….” Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region’s Basin Plan or statewide water quality control plans such as the California Ocean Plan.
† “Marine communities, including vertebrate, invertebrate, algae, and plant species, shall not be degraded.”

4.3. Carbaryl

Chemical Abstracts Service Registry Number: 63-25-2

Synonyms: carbaryl, Sevin, naphthalene-1-yl methylcarbamate, 1-naphthyl N-methylcarbamate

General Information[80,81,82]: Carbaryl is a carbamate insecticide widely applied for controlling a variety of pests on many crops as well as livestock and poultry. Carbaryl is a white crystalline solid that is essentially odorless and slightly water-soluble. It is available in the U.S. as aqueous dispersions, dusts, emulsifiable concentrates, granules, wettable powder, and baits. Carbaryl is non-flammable and burns with difficulty, though liquid formulations with organic solvents are more flammable, and can create corrosive or toxic fumes when heated to decomposition.

Carbaryl is not readily volatized into the air from soil or aqueous solutions, given its low vapor pressure and Henry’s Law constant. Carbaryl moderately adsorbs to soils and sediments. It is primarily degraded by hydrolysis with some photolysis and microbial uptake with degradation times ranging from a matter of hours to several days under anaerobic, darker conditions.

The primary risk of carbaryl use is to agricultural workers near where the pesticide is applied. The general population has much lower risk of carbaryl exposure but people can encounter carbaryl by inhaling ambient air, ingesting contaminated food or water, and dermal contact with carbaryl-containing pesticide products. Acute exposure can cause skin and eye irritation and more seriously impairment of the central nervous system, specifically cholinesterase inhibition, leading to vomiting, nausea, blurred vision, convulsions, coma, and respiratory failure. Chronic exposure increases the risk of cholinesterase inhibition, which is reversible by ending the exposure, causing headaches, memory loss, weakness, and anorexia. Carbaryl is not considered to be a human carcinogen (Group D). Ingestion testing on animals show carbaryl to be moderately to highly toxic with acute exposure and less toxic with chronic exposure, though kidney and liver effects have been observed. Generally, carbaryl is only slightly toxic to birds and mammals but can be potentially highly toxic to aquatic organisms and honeybees. Plants are able to degrade carbaryl with little to no adverse effects.

Water Quality Objectives: The updated U.S. EPA Aquatic Life Water Quality Criteria are shown in the Table below. While the Basin Plan does not include specific aquatic life objectives for Carbaryl, it is addressed by the narrative toxicity objective that applies to toxic substances in general. The Ocean Plan also does not contain numeric water quality objectives for Carbaryl for the protection of aquatic life. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: “Marine communities, including vertebrate, invertebrate, algae, and plant species, shall not be degraded.” Additionally, Table 1 of the Ocean Plan includes numeric toxicity objectives, which aid in addressing pollutants that may not have specific numeric objectives.

Table 29: Updated U.S. EPA Aquatic Life Water Quality Criteria and current applicable WQOs for Carbaryl.

Updated EPA Water Quality Criteria			
EPA Aquatic Life Criteria	**Freshwater**	**CMC (acute) (µg/L)**	2.1
		CCC (chronic) (µg/L)	2.1
	Saltwater	**CMC (acute) (µg/L)**	1.6
		CCC (chronic) (µg/L)	
Los Angeles Water Board Basin Plan			
CTR Aquatic Life criteria	**Freshwater**	**CMC (acute) (µg/L)**	-
		CCC (chronic) (µg/L)	-
	Saltwater	**CMC (acute) (µg/L)**	-
		CCC (chronic) (µg/L)	-
Narrative Toxicity Objective*			
California Ocean Plan			
Numerical Water Quality Objective for Protection of Marine Aquatic Life	**Saltwater**	**6-Month Median (µg/L)**	-
		Daily Maximum (µg/L)	-
		Instantaneous Maximum (µg/L)	-
Narrative Objective**			

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

** "Marine communities, including vertebrate, invertebrate, algae, and plant species, shall not be degraded."

4.4. Diazinon

Chemical Abstracts Service Registry Number: 333-41-5

Synonyms: Dimpylate, diazinone, oleodiazinon, Neocidol

General Information[83,84]: Diazinon is an organothiophosphorus insecticide usually used to protect rice and fruit trees from animal ectoparasites. In its pure form, diazinon is a colorless, essentially odorless, oily liquid. As of 2004, diazinon has not been used for indoor-use or residential products. Diazinon is insoluble in water. It is essentially non-flammable and non-combustible but can emit toxic fumes when heated to decomposition above 120 degrees Celsius or in the presence of strong oxidants. Due to its high susceptibility to oxidation, diazinon should be kept from prolonged exposure to air.

Diazinon is a synthetic chemical that is only released as the result of human activity, entering the air primarily from volatilization from soil after extensive agricultural use and entering surface water by point source discharges, drift from pesticide application, and agricultural runoff. Diazinon is not particularly water soluble and moderately binds to soils and sediments based on organic content, leaving some risk of leaching into groundwater. Diazinon in air is expected to exist in both the particulate and gaseous phases and will photodegrade. In water and soil, diazinon can be degraded by hydrolysis and photolysis, both strongly affected by pH and temperature, and by microorganisms.

As it does not volatize easily, inhalation of the gas is less likely than inhalation of diazinon aerosols. Its systemic effects are not well studied but it exhibits little to no toxic effects in studies on respiratory, gastrointestinal, and cardiovascular systems. No cases of death have been attributed to chronic diazinon exposure but acute ingestion of high levels of diazinon has significant and potentially lethal neurological effects, specifically inhibiting of a chemical in the brain called acetylcholinesterase. Cholinesterase inhibitors such has diazinon are very fast-acting poisons but an antidote, atropine, can be administered by trained personnel. Serious exposure can result in neuromuscular dysfunction, nausea/vomiting, anxiety, apathy, confusion, headaches, convulsions, seizures, and coma. It should be noted that almost all of the cases of diazinon poisoning studied did not involve pure diazinon. Diazinon is not considered a human carcinogen (Group A4) with evidence of noncarcinogenicity. Diazinon is very toxic to aquatic life though it does not significantly bioaccumulate in aquatic organisms.

Water Quality Objectives: The updated U.S. EPA Aquatic Life Water Quality Criteria are shown in the Table below. While the Basin Plan does not include specific aquatic life objectives for Diazinon, it is addressed by the narrative toxicity objective that applies to toxic substances in general. The Ocean Plan also does not contain numeric water quality objectives for Diazinon for the protection of aquatic life. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: "Marine communities, including vertebrate, invertebrate, algae, and plant species, shall not be degraded." Additionally, Table 1 of the Ocean Plan includes numeric toxicity objectives, which aid in addressing pollutants that may not have specific numeric objectives.

Table 30: Updated U.S. EPA Aquatic Life Water Quality Criteria and current applicable WQOs for Diazinon.

Updated EPA Water Quality Criteria			
EPA Aquatic Life Criteria	**Freshwater**	**CMC (acute) (µg/L)**	0.17
		CCC (chronic) (µg/L)	0.17
	Saltwater	**CMC (acute) (µg/L)**	0.82
		CCC (chronic) (µg/L)	0.82
Los Angeles Water Board Basin Plan			
CTR Aquatic Life criteria	**Freshwater**	**CMC (acute) (µg/L)**	-
		CCC (chronic) (µg/L)	-
	Saltwater	**CMC (acute) (µg/L)**	-
		CCC (chronic) (µg/L)	-
Narrative Toxicity Objective*			

California Ocean Plan			
Numerical Water Quality Objective for Protection of Marine Aquatic Life	Saltwater	6-Month Median (μg/L)	-
		Daily Maximum (μg/L)	-
		Instantaneous Maximum (μg/L)	-
Narrative Objective**			

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.
** "Marine communities, including vertebrate, invertebrate, algae, and plant species, shall not be degraded."

4.5. Nonylphenol

Chemical Abstracts Service Registry Number: 104-40-5

Synonyms: 4-nonylphenol, 4-n-nonylphenol, P-nonylphenol, phenol, 4-nonyl-

General Information[85,86,87,88]**:** Nonylphenol (NP) is an industrial synthetic chemical primarily used in the creation of Nonylphenol Ethoxylates (NPEs). Nonylphenol is a clear or pale yellow viscous liquid with a sickeningly sweet and tarry (phenol) odor. The NPEs created from nonylphenol are widely employed as detergents, emulsifiers, and surfactants in both household and industrial products (e.g. paints, cosmetics, plastics, lubricant oils, construction materials, paper, and processing fuels, metals, textiles, agricultural chemicals and leather). It is effectively insoluble in water but very soluble in organic solvents like ether, acetone, or benzene. It is both combustible and flammable, emitting toxic fumes when heated to decomposition.

Nonylphenol is persistent in aquatic environments as it is not readily biodegradable or water soluble and takes months at minimum for abiotic degradation in surface waters or soil. Nonylphenol has moderate vapor pressure and Henry's Law constant so it volatizes in small amounts, which will be degraded rapidly by hydroxyl radicals and thusly have low persistence in the atmosphere. The continued widespread usage of NPEs in industrial laundry detergents and other products cause large amounts of NPEs to enter the sewage treatment system where it degrades into nonylphenol, which cannot be effectively broken down by wastewater treatment. In sewage treatment and after being released into the environment, NPEs readily degrade into nonylphenol, which is more toxic to aquatic organisms and more persistent.

There is little evidence that nonylphenol is particularly dangerous to humans, high levels causing some respiratory, digestive, and dermal irritation. Ingestion or inhalation of high concentrations of nonylphenol can cause damage to the liver, kidney, and cardiovascular system. Nonylphenol is not considered a carcinogen. Nonylphenol significantly bioaccumulates and bioconcentrates in the tissues of aquatic organisms and birds, though it does not significantly biomagnify as it moves up the food chain. It is highly toxic to aquatic organisms and has adverse developmental and reproductive effects on fish, interfering with osmoregulation for some sensitive species. Through the combination of its capacity for bioaccumulation and its persistence, nonylphenol can be transported huge distances, potentially globally.

Water Quality Objectives: The updated U.S. EPA Aquatic Life Water Quality Criteria are shown in the Table below. While the Basin Plan does not include specific aquatic life objectives for Nonylphenol, it is addressed by the narrative toxicity objective that applies to toxic substances in general. The Ocean Plan also does not contain numeric water quality objectives for Nonylphenol for the protection of aquatic life. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: "Marine communities, including vertebrate, invertebrate, algae, and plant species, shall not be degraded." Additionally, Table 1 of the Ocean Plan includes numeric toxicity objectives, which aid in addressing pollutants that may not have specific numeric objectives.

Table 31: Updated U.S. EPA Aquatic Life Water Quality Criteria and current applicable WQOs for Nonylphenol.

Updated EPA Water Quality Criteria			
EPA Aquatic Life Criteria	Freshwater	CMC (acute) (µg/L)	28
		CCC (chronic) (µg/L)	6.6
	Saltwater	CMC (acute) (µg/L)	7
		CCC (chronic) (µg/L)	1.7
Los Angeles Water Board Basin Plan			
CTR Aquatic Life criteria	Freshwater	CMC (acute) (µg/L)	-
		CCC (chronic) (µg/L)	-
	Saltwater	CMC (acute) (µg/L)	-
		CCC (chronic) (µg/L)	-
Narrative Toxicity Objective*			
California Ocean Plan			
Numerical Water Quality Objective for Protection of Marine Aquatic Life	Saltwater	6-Month Median (µg/L)	-
		Daily Maximum (µg/L)	-
		Instantaneous Maximum (µg/L)	-
Narrative Objective**			

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

** "Marine communities, including vertebrate, invertebrate, algae, and plant species, shall not be degraded."

4.6. Tributyltin (TBT)

Chemical Abstracts Service Registry Number: 813-19-4

Synonyms: AC1O3GFA, DTXSID70231041, SC-69380, FT-0626946

General Information[89,90,91,92,93]: Tributyltin (TBT) is a liquid that has been used extensively as a biocide in antifouling paints for ship hulls. Other industrial uses include slime control in paper mills, disinfection of circulating cooling waters, and wood preservation. It is an unstable substance by itself and so it is often combined with another element such as oxygen. In antifouling paints, TBT slowly releases into the surrounding water, hindering the growth and attachment of aquatic organisms (e.g. slime, barnacles, etc.). However, this leaching into the surrounding water combined with TBT's low solubility in water is the primary way that TBT contaminates larger water bodies.

TBT's low solubility in water causes long persistence times in aqueous environments. However, TBT is very lipid soluble and so easily bioaccumulates in fat tissues. These properties also lead TBT to strongly bind to suspended sediments or organic materials, varying depending on particle size and organic composition. The predilection to bind to particles tends to restrict TBT to the water body in which it is released, though that is not to say that it will remain within a small area within that water body. TBT has not been found in groundwater. TBT does not easily volatize, but health risks have been identified for mixing TBT-containing paints together as TBT can be released into the atmosphere during mixing. TBT takes about three months to degrade in water, but potentially years under anaerobic conditions. The breakdown of TBT eventually creates tin ions and all breakdown products are less toxic than TBT.

TBT is moderately to severely toxic to mammals, causing moderate to severe eye and skin irritation in humans. Inhalation of TBT can cause interfered breathing, headaches, weakness, and lack of coordination. High levels can damage reproductive and central nervous systems in studied mammals. Exposure risk for the general population is low but occupational exposure can occur through dermal contact during TBT production or use. TBT is not considered a human carcinogen (Group A4). However, it is highly toxic to marine organisms, particularly mollusks and crustaceans. At low levels, TBT causes adverse structural changes and growth retardation in marine mollusks. Some species of finfish can degrade TBT in small amounts due to special enzymes, but it can be dangerous to other species, particularly younger individuals. Freshwater species bioaccumulate TBT faster than marine organisms. The biggest ecological problem regarding TBT is that it can affect large numbers of non-target organisms.

Water Quality Objectives: The updated U.S. EPA Aquatic Life Water Quality Criteria are shown in the Table below. While the Basin Plan does not include specific aquatic life objectives for TBT, it is addressed by the narrative toxicity objective that applies to toxic substances in general. The Ocean Plan also does not contain numeric water quality objectives for TBT for the protection of aquatic life. However, under E. Biological Characteristics, the Ocean Plan has the following narrative objective: "Marine communities, including vertebrate, invertebrate, algae, and plant species, shall not be degraded." Additionally, Table 1 of the Ocean Plan includes numeric toxicity objectives, which aid in addressing pollutants that may not have specific numeric objectives.

Table 32: Updated U.S. EPA Aquatic Life Water Quality Criteria and current applicable WQOs for TBT.

Updated EPA Water Quality Criteria			
EPA Aquatic Life Criteria	**Freshwater**	**CMC (acute) (µg/L)**	0.46
		CCC (chronic) (µg/L)	0.072
	Saltwater	**CMC (acute) (µg/L)**	0.42
		CCC (chronic) (µg/L)	0.0074
Los Angeles Water Board Basin Plan			
CTR Aquatic Life criteria	**Freshwater**	**CMC (acute) (µg/L)**	-
		CCC (chronic) (µg/L)	-
	Saltwater	**CMC (acute) (µg/L)**	-
		CCC (chronic) (µg/L)	-
Narrative Toxicity Objective*			
California Ocean Plan			
Numerical Water Quality Objective for Protection of Marine Aquatic Life	**Saltwater**	**6-Month Median (µg/L)**	-
		Daily Maximum (µg/L)	-
		Instantaneous Maximum (µg/L)	-
Narrative Objective**			

* "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

** "Marine communities, including vertebrate, invertebrate, algae, and plant species, shall not be degraded."

4.7. Aquatic Life Section 304(a) Water Quality Criteria Recommendations for Pollutants Included in the CTR

As mentioned for Human Health CTR criteria, pollutants that are part of the CTR may require further action by the U.S.EPA before they could be applied in regulatory actions. Detailed descriptions of these pollutants are not included in this appendix; however, more details about these chemicals are provided on U.S. EPA's website[o,p]. The list of section 304(a) aquatic life water quality criteria recommendations published by the U.S. EPA since May 30, 2000 that are part of the CTR is provided in the table below, along with the WQOs currently applicable.

[o] https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table

[p] https://www.epa.gov/wqs-tech/water-quality-standards-establishment-numeric-criteria-priority-toxic-pollutants-state

Table 33: Section 304(a) aquatic life water quality criteria recommendations published by the U.S. EPA since May 30, 2000 that are part of the CTR and current applicable WQOs.

Chemical	CAS No.	*Updated EPA Water Quality Criteria*				*Los Angeles Water Board Basin Plan*					*California Ocean Plan*			
		Aquatic Life Criteria				CTR Aquatic Life				Toxicity Objective **	Water Quality Objective			Narrative Objective ‡
		Freshwater		Saltwater		Freshwater*		Saltwater			Saltwater			
		CMC (acute) (µg/l)	CCC (chronic) (µg/l)	CMC (acute) (µg/l)	CCC (chronic) (µg/l)	CMC (acute) (µg/l)	CCC (chronic) (µg/l)	CMC (acute) (µg/l)	CCC (chronic) (µg/l)		6-Month Median	Daily Max	Instant-aneous Max	
Cadmium	7440-43-9	1.8	0.72	33	7.9	4.3	2.2	42	9.3		1	4	10	
Copper	7440508	Biotic Ligand Model		4.8	3.1	13	9	4.8	3.1		3	12	30	
Selenium	7782-49-2	multi-media criteria		(290)[†]	(71)[†]	20	5	290	71		15	60	150	

* These numbers are based on a default water-effect ratio (WER) of 1. However, site-specific WERs have been derived for a number of waterbodies in the Los Angeles River and Calleguas Creek watersheds.

** "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life…." Where necessary, the Water Boards identify numeric thresholds to implement narrative objectives contained in the Region's Basin Plan or statewide water quality control plans such as the California Ocean Plan.

† The EPA water quality criteria for selenium in saltwater were established in 1999, and are therefore not part of this review.

‡ "Marine communities, including vertebrate, invertebrate, algae, and plant species, shall not be degraded."

5. Next Steps

As mentioned in the introduction, this document is a first step in addressing U.S. EPA's direction to states and tribes in its WQS Rule, and presents a cursory review of the current regulatory status in the Los Angeles Region of the 118 section 304(a) water quality criteria recommendations published by the U.S. EPA since May 30, 2000.

Further steps will involve an evaluation of which of the new or revised criteria to consider for adoption and incorporation into the Basin Plan. Where an update or adoption of a section 304(a) water quality criteria recommendation is not recommended, the reasons for this determination will be documented.

When incorporation into the Basin Plan is considered, a tiered approach will be developed to determine in which order criteria should be addressed. Staff will take into consideration how much of a priority to the Los Angeles Water Board staff and stakeholders the incorporation of a specific criterion is, as well as the time required for any data collection or studies necessary to incorporate a specific criterion into the Basin Plan.

Following this prioritization exercise, staff will proceed with the water quality objective updates in the determined order. Stakeholders will have the opportunity to comment on the initial prioritization, as well as each of the updates prior to its consideration by the Regional Water Board as part of the public notice and comment process for each individual Basin Plan amendment.

6. References

3.1

1. "Antimony." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/antimony. (accessed February 7, 2018).
2. ATSDR (Agency for Toxic Substances and Disease Registry). (2017) "Toxicological profile for Antimony and Compounds." Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. Available online at https://www.atsdr.cdc.gov/toxprofiles/tp23.pdf (accessed February 7, 2018)

3.2

3. "Benzene." Pubchem Open Chemistry Database. https://pubchem.ncbi.nlm.nih.gov/compound/241. (accessed February 7, 2018)
4. ATSDR (Agency for Toxic Substances and Disease Registry). (2007) "Toxicological profile for Benzene." Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. Available online at https://www.atsdr.cdc.gov/toxprofiles/tp3.pdf (accessed February 7, 2018)

3.3

5. ATSDR (Agency for Toxic Substances and Disease Registry). (1989) "Public Health Statement Bis(Chloromethyl) Ether." Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. Available online at https://www.atsdr.cdc.gov/ToxProfiles/tp128-c1-b.pdf (accessed February 7, 2018)
6. "Bis(chloromethyl) Ether." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/bis_chloromethyl__ether (accessed February 7, 2018)
7. ATSDR (Agency for Toxic Substances and Disease Registry). (2017) "Toxicological Profile for Bis(Chloromethyl)Ether (BCME)." Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. Available online at https://www.atsdr.cdc.gov/toxprofiles/tp128.pdf (accessed February 7, 2018)

3.4

8. "Chloroform." PubChem Open Chemistry Database. https://pubchem.ncbi.nlm.nih.gov/compound/chloroform (accessed February 7, 2018)
9. ATSDR (Agency for Toxic Substances and Disease Registry). (1997) "Toxicological Profile for Chloroform." Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. Available online at https://www.atsdr.cdc.gov/toxprofiles/tp6.pdf (accessed February 7, 2018)

3.5

10. "ChemicalWatch Factsheet 2,4-D." Beyond Pesticides. Available online at http://www.beyondpesticides.org/assets/media/documents/pesticides/factsheets/2-4-D.pdf (accessed February 7, 2018)
11. "2,4-dichlorophenoxyacetic acid." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/1486 (accessed February 7, 2018)
12. ATSDR (Agency for Toxic Substances and Disease Registry). (2017) "Toxicological profile 2,4-Dichlophenoxyacetic Acid." Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. Available online at https://www.atsdr.cdc.gov/toxprofiles/tp210.pdf (accessed February 7, 2018)
13. 2,4-D Technical Fact Sheet." National Pesticide Information Center, Corvalis, OR. Available online at http://npic.orst.edu/factsheets/archive/2,4-DTech.html (accessed February 7, 2018)

3.6

14. "Fenoprop." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/7158 (accessed February 7, 2018)
15. CAL EPA. (2002) "Public Health Goal for Silvex in Drinking Water" Office of Environmental Heath Hazard Assessment, Pesticide and Environmental Toxicology Section, Sacramento, CA. Available online at https://oehha.ca.gov/media/downloads/water/public-health-goal/silvexposting53002.pdf (accessed February 7, 2018)

3.7

16. "Cyanide." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/cyanide (accessed February 9, 2018)
17. ATSDR (Agency for Toxic Substances and Disease Registry). (2006) "Toxicological profile for Cyanide." Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. Available online at https://www.atsdr.cdc.gov/toxprofiles/tp8.pdf (accessed February 8, 2018)
18. Pesticide Action Network (PAN). (2016) "Sodium Cyanide – Identification, toxicity, use, water pollution potential, ecological toxicity, and regulatory information" PAN Pesticides Database – Chemicals, Oakland, CA. Available online at http://pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC34366 (accessed February 8, 2018)

3.8

19. ATSDR (Agency for Toxic Substances and Disease Registry). (1995) "Toxicological profile for Dinitrophenols." Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. Available online at http://www.atsdr.cdc.gov/toxprofiles/tp64.pdf (accessed February 8, 2018)

20. "2,4-dinitrophenol." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/1493 (accessed February 8, 2018)

3.9

21. ATSDR (Agency for Toxic Substances and Disease Registry). (2005) "Toxicological profile for Alpha-, Beta-, Gamma-, and Delta-Hexachlorocyclohexane." Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. Available online at https://www.atsdr.cdc.gov/toxprofiles/tp43.pdf (accessed February 8, 2018)
22. "Lindane." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/727 (accessed February 8, 2018)

3.10

23. "Methylmercury (1+)." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/6860 (accessed February 7, 2018)
24. National Research Council (US) Committee on the Toxicological Effects of Methylmercury. (2000) "Toxicological Effects of Methylmercury." National Academies Press, Washington D.C. Available online at https://www.nap.edu/read/9899/chapter/3 (accessed February 7, 2018)

3.11

25. U.S. EPA. (2000) "Health Effects Notebook for Hazardous Air Pollutants: Methoxychlor." U.S. EPA., Washington D.C. Available online at https://www.epa.gov/sites/production/files/2016-09/documents/methoxychlor.pdf (accessed February 6, 2018)
26. "Methoxychlor." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/methoxychlor (accessed February 6, 2018)
27. ATSDR (Agency for Toxic Substances and Disease Registry). (2002) " "Toxicological Profile for Methoxychlor." Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. Available online at https://www.atsdr.cdc.gov/toxprofiles/tp47.pdf (accessed February 6, 2018)

3.12

28. U.S. National Library of Medicine. (2012) "N,N-Dibutylnitrosoamine." ToxNet Toxicology Data Network, Washington D.C. Available online at https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+5107 (accessed February 6, 2018)
29. "N-Nitrosodibutylamine." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/N-Nitrosodibutylamine (accessed February 6, 2018)
30. U.S. Department of Labor. ("N-Nitrosodibuylamine." Occupational Safety and Health Administration (OSHA), Washington D.C. Available online at

https://www.osha.gov/dts/chemicalsampling/data/CH_257960.html (accessed February 6, 2018)

3.13

31. "N-Nitrosodibutylamine." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/n-nitrosodiethylamine (accessed February 6, 2018)
32. ChemicalBook. (2018). "N-Nitrosodibutylamine." ChemicalBook. Available online at http://www.chemicalbook.com/ChemicalProductProperty_EN_CB8732709.htm (accessed February 6, 2018)
33. Pesticide Action Network (PAN). (2016) "N-Nitrosodiethylamine – Identification, toxicity, use, water pollution potential, ecological toxicity, and regulatory information." PAN Pesticides Database – Chemicals, Oakland, CA. Available online at http://www.pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC42211 (accessed February 6, 2018)

3.14

34. "N-Nitrosopyrrolidine." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/n-nitrosopyrrolidine (accessed February 6, 2018)
35. "Evaluation of the Potential Carcinogenicity of N-Nitrosopyrrolidine." US EPA. Available online at https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=34410&CFID=58473694&CFTOKEN=97920294 (accessed February 6, 2018)
36. Pesticide Action Network (PAN). (2016) "N-Nitrosopyrrolidine – Identification, toxicity, use, water pollution potential, ecological toxicity, and regulatory information." PAN Pesticides Database – Chemicals, Oakland, CA Available online at http://www.pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC42626 (accessed February 6, 2018)

3.15

37. Minnesota Pollution Control Agency (MPCA). (2008) "Bacteria: Sources, Types, and Impacts on Water Quality – A General Overview." MPCA, St. Paul, MN. Available online at https://www.pca.state.mn.us/sites/default/files/wq-iw3-20.pdf (accessed February 13, 2018)
38. Ashbolt, Nicholas, Grabow, Willie O.K. & Snozzi, Mario. (2001) "Chapter 13 – Indicators of microbial water quality." In Bartram, Jamie & Fewtrell, Lorna (Eds.) "Water Quality: Guidelines, Standards and Health." IWA Publishing, London, UK. Available online at http://www.who.int/water_sanitation_health/dwq/iwachap13.pdf (accessed February 12, 2018)

39. Meals, Donald W., Harcum, Jon B., & Dressing, Steven A. (2013) “Monitoring for microbial pathogens and indicators.” TechNotes 9, September 2013. Developed for U.S. EPA by Tetra Tech, Inc., Fairfax, VA, 1-29p. Available online at https://www.epa.gov/sites/production/files/2016-05/documents/tech_notes_9_dec2013_pathogens.pdf (accessed February 12, 2018)

3.16

40. Center for Disease Control (CDC). (2015) “International Chemical Safety Cards: Pentachlorobenzene.” The National Institute for Occupational Safety and Health (NIOSH), Atlanta, GA. Available online at http://www.cdc.gov/niosh/ipcsneng/neng0531.html (accessed February 5, 2018)

41. “HSDB: Pentachlorobenzene.” TOXNET Toxicology Data Network. Available online at https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/r?dbs+hsdb:@term+@rn+@rel+608-93-5 (accessed February 5, 2018)

42. “Pentachlorobenzene” PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/11855 (accessed February 5, 2018)

3.17

43. “Health Effects Notebook for Hazardous Air Pollutants: Selenium Compounds.” US EPA. Available online at https://www.epa.gov/sites/production/files/2016-09/documents/selenium-compounds.pdf (accessed February 5, 2018)

44. “Selenium.” PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/6326970 (accessed February 5, 2018)

45. “Toxicology Profile for Selenium.” Agency for Toxic Substances and Disease Registry. https://www.atsdr.cdc.gov/toxprofiles/tp92.pdf (accessed February 5, 2018)

3.18

46. “Vinyl Chloride.” PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/vinyl_chloride (accessed February 7, 2018)

47. “Toxicology Profile for Vinyl Chloride.” Agency for Toxic Substances and Disease Registry. https://www.atsdr.cdc.gov/toxprofiles/tp20.pdf (accessed February 7, 2018)

3.19

48. U.S. EPA. (2005) “Toxicological Review of Zinc and Compounds.” U.S. Environmental Protection Agency, Washington D.C. Available online at https://cfpub.epa.gov/ncea/iris/iris_documents/documents/toxreviews/0426tr.pdf (accessed February 5, 2018)

49. “Zinc.” PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/zinc (accessed February 5, 2018)

50. ATSDR (Agency for Toxic Substances and Disease Registry). (1995) “Toxicological profile for zinc.” Public Health Service, U.S. Department of Health and Human Services,

Atlanta, GA. Available online at https://www.atsdr.cdc.gov/ToxProfiles/tp60.pdf (accessed February 5, 2018)

51. U.S. EPA. (2005) Guidelines for carcinogen risk assessment. Risk Assessment Forum, Washington, DC. EPA/630/P-03/001B, NCEA-F-0644b. Available online at http://www.epa.gov/iris/backgr-d.htm (accessed February 5, 2018)

3.20

52. ATSDR (Agency for Toxic Substances and Disease Registry). (1995) "Toxicological profile for 1,1,1-trichloroethane." Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. Available online at http://www.atsdr.cdc.gov/PHS/PHS.asp?id=430&tid=76 (accessed February 2, 2018)

53. "1,1,1-Trichloroethane." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/1_1_1-trichloroethane (accessed February 2, 2018)

3.21

54. ATSDR (Agency for Toxic Substances and Disease Registry). "1,2,4,5-Trichlorobenzene." Agency for toxic Substances and Disease Registry, Division of Toxicology, Atlanta, GA. Available online at https://archive.epa.gov/epawaste/hazard/wastemin/web/pdf/tetchlben.pdf (accessed February 2, 2018)

55. "1,2,4,5-Tetrachlorobenzene." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/1_2_4_5-tetrachlorobenzene (accessed February 2, 2018)

56. "1,2,4,5-Tetrachlorobenzene." IPCS INCHEM. Available online at http://www.inchem.org/documents/icsc/icsc/eics0676.htm (accessed February 2, 2018)

57. "1,2,4,5-Tetrachlorobenzene; CASRN 95-94-3." Integrated Risk Information System (IRIS)) Chemical Assessment Summary. U.S. EPA. Available online at https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0107_summary.pdf (accessed February 2, 2018)

58. New Jersey Department of Health and Senior Services. (2002) "Hazardous Substance Fact Sheet 1,2,4,5 – Tetrachlorobenzene." New Jersey Department of Health and Senior Services Occupation Health Service, Trenton, NJ. Available online at http://nj.gov/health/eoh/rtkweb/documents/fs/2965.pdf (accessed February 2, 2018)

3.22

59. New Jersey Department of Health and Senior Services. (2005) "Hazardous Substance Fact Sheet 1,2,4 – Trichlorobenzene." New Jersey Department of Health and Senior Services Occupation Health Service, Trenton, NJ. Available online at http://nj.gov/health/eoh/rtkweb/documents/fs/1887.pdf (accessed February 2, 2018)

60. U.S. National Library of Medicine. (2010) "HSDB: 1,2,4-Trichlorobenzene." TOXNET Toxicology Data Network, Washington D.C. Available online at https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/r?dbs+hsdb:@term+@rn+@rel+120-82-1 (accessed February 2, 2018)

61. California EPA (CAL EPA). (2005) "Evidence of Carcinogenicity of 1,2,4-Trichlorobenzene." Reproductive And Cancer Hazard Assessment Branch, Office of Environmental Health Hazard Assessment, CAL EPA, Sacramento, CA. Available online at https://oehha.ca.gov/media/downloads/proposition-65/chemicals/hid124trichlorobenzenefinal.pdf (accessed February 2, 2018)

62. Pesticide Action Network (PAN). (2016) "1,2,4-Trichlorobenzene – Identification, toxicity, use, water pollution potential, ecological toxicity, and regulatory information." PAN Pesticides Database – Chemicals, Oakland, CA. Available online at http://pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC34629 (accessed February 2, 2018)

63. "1,2,4 – Trichlorobenzene." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/1_2_4-trichlorobenzene (accessed February 2, 2018)

3.23

64. "1,3-Dichloropropene." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/cis-1_3-DICHLOROPROPENE (accessed February 2, 2018)

65. Vidrio, Edgar. (2012) "1,3-Dichlopropene Risk Characterization Document – Environmental Fate." Environmental Monitoring Branch, Department of Pesticide Regulation, CAL EPA. Available online at http://www.cdpr.ca.gov/docs/emon/pubs/fatememo/13-d.pdf (accessed February 2, 2018)

66. U.S. National Library of Medicine. (2016) "HSDB: 1,3-Dichloropropene." TOXNET Toxicology Data Network, Washington D.C. Available online at https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+1109 (accessed February 2, 2018)

3.24

67. "2,4,5-Trichlorophenol." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/2_4_5-trichlorophenol (accessed February 2, 2018)

68. New Jersey Department of Health and Senior Services. (2006) "Hazardous Substance Fact Sheet 2,4,5-Trichlorophenol." New Jersey Department of Health and Senior Services Occupation Health Service, Trenton, NJ. Available online at http://nj.gov/health/eoh/rtkweb/documents/fs/1895.pdf (accessed February 2, 2018)

69. U.S. EPA. (2000) “2,4,5-Trichlorophenol.” U.S. EPA, Washington D.C. Available online at https://www.epa.gov/sites/production/files/2016-09/documents/2-4-5-trichlorophenol.pdf (accessed February 2, 2018)

70. Center for Disease Control (CDC). (2015) “International Chemical Safety Cards: 2,4,5-Trichlorophenol.” The National Institute for Occupational Safety and Health (NIOSH), Atlanta, GA. Available online at https://www.cdc.gov/niosh/ipcsneng/neng0879.html (accessed February 2, 2018)

71. Pesticide Action Network (PAN). (2016) “2,4,5-Trichlorophenol – Identification, toxicity, use, water pollution potential, ecological toxicity, and regulatory information.” PAN Pesticides Database – Chemicals, Oakland, CA. Available online at http://www.pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC34634 (accessed February 2, 2018)

3.25

72. “Spectrum Chemical Fact Sheet.” Florida Spectrum Environmental Services, Fort Lauderdale, FL. Available online at http://www.speclab.com/compound/c59507.htm (accessed February 2, 2018)

73. “3-Methyl-4-Chlorophenol.” PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/4-Chloro-3-methylphenol (accessed February 1, 2018)

74. “4-chloro-30methyl phenol.” UK Marine Special Areas of Conservation Project. Available online at http://www.ukmarinesac.org.uk/activities/water-quality/wq8_31.htm (accessed February 1, 2018)

4.1

75. ATSDR (Agency for Toxic Substances and Disease Registry). (2007) “Toxicological profile for Acrolein.” Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. Available online at https://www.atsdr.cdc.gov/ToxProfiles/tp124.pdf (accessed February 1, 2018)

76. Eisler, Ronald. (1994) “Acrolein Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review.” U.S. Department of the Interior, National Biological Survey, Washington D.C. Available online at https://www.pwrc.usgs.gov/eisler/CHR_28_Acrolein.pdf (accessed January 31, 2018)

77. “Acrolein.” PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/acrolein (accessed February 13, 2018)

4.2

78. ATSDR (Agency for Toxic Substances and Disease Registry). (2004) “Toxicological profile for Ammonia.” Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. Available online at https://www.atsdr.cdc.gov/toxprofiles/tp126.pdf (accessed January 31, 2018)

79. “Ammonia” PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/222 (accessed February 13, 2018)

4.3

80. Sue, Xu. (2000) Environmental Monitoring, Department of Pesticide Regulation, Sacramento, CA. Available online at http://www.cdpr.ca.gov/docs/emon/pubs/fatememo/carbaryl.pdf (accessed January 31, 2018)
81. U.S. EPA. (2000) “Carbaryl.” U.S. EPA, Washington D.C. Available online at https://www.epa.gov/sites/production/files/2016-09/documents/carbaryl.pdf (accessed January 31, 2018)
82. “Carbaryl.” PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/6129 (accessed February 13, 2018)

4.4

83. ATSDR (Agency for Toxic Substances and Disease Registry). (2008) “Toxicological profile for Diazinon.” Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. Available online at https://www.atsdr.cdc.gov/toxprofiles/tp86.pdf (accessed January 31, 2018)
84. “Diazinon.” PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/diazinon (accessed January 31, 2018)

4.5

85. CAL EPA. (2009) “Toxicological Profile for Nonylphenol.” Integrated Risk Assessment Branch,Office of Environmental Health Hazard Assessment, CAL EPA, Sacramento, CA. Available online at http://www.opc.ca.gov/webmaster/ftp/project_pages/MarineDebris_OEHHA_ToxProfiles/Nonylphenol%20Final.pdf (accessed January 30, 2018)
86. Bakke, David. (2003) “Human and Ecological Risk Assessment of Nonylphenol Polyethorxylate-based (NPE) Surfactants in Forest Service Herbicide Applications.” US Department of Agriculture (USDA) Forest Service, Pacific Southwest Region (Region 5). Available online at https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5346866.pdf (accessed January 30, 2018)
87. “4-nonylphenol.” PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/7390 (accessed February 13, 2018)
88. Lah, Katarina and Mergel, Maria. (2011) “Tibutyltin.” Toxipedia. Available online at http://www.toxipedia.org/display/toxipedia/Nonylphenol+and+Nonylphenol+Ethoxylates (accessed February 2, 2018)

4.6

89. Lah, Katarina and Mergel, Maria. (2011) "Tibutyltin." Toxipedia. Available online at http://www.toxipedia.org/display/toxipedia/Tributyltin (accessed February 2, 2018)
90. Extension Toxicology Network (EXTONET). (1993) "Pesticide Information Profile Tributyltin." Cooperative Extension Offices of Cornell University, Oregon State University, Michigan State University, and UC Davis, CA. Available online at http://pmep.cce.cornell.edu/profiles/extoxnet/pyrethrins-ziram/tributyltin-ext.html (accessed January 30, 2018)
91. "688-73-3." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/Tributyltin (accessed January 31, 2018)
92. Antizar-Ladislao, Blanka. (2018) "Environmental levels, toxicity, and human exposure to tributylin (TBT)-contaminated marine environment. A review." Environment International, Volume 3, Issue 2, pages 292-308. Available online at https://www.sciencedirect.com/science/article/pii/S0160412007001845 (accessed January 30, 2018)
93. "AC1O3GFA." PubChem Open Chemistry Database. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/24189553 (accessed February 13, 2018)